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Tehrān-Karaj

05

Young Cities Research Paper Series, Volume 05

Urban Challenges and Urban Design

Approaches for Resource-Efficient and Climate-Sensitive Urban Design in the MENA Region

Elke Pahl-Weber, Sebastian Seelig, Holger Ohlenburg, Nadine Kuhla von Bergmann (Eds.)

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Elke Pahl-Weber, Sebastian Seelig, Holger Ohlenburg, and Nadine Kuhla von Bergmann

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Preface

Elke Pahl-Weber | Nadine Kuhla von Bergmann

In an era defined by climate change, a lack of social cohesion, rapidly accelerating technological innovations, economic shifts, and the transformation of political systems, solutions must be pursued at every level of action. This book shows how solutions from urban design can, by integrating the approaches of multiple disciplines, be the first steps towards envisioning the city of the future.

This book is compiled for readers from a range of professional backgrounds. Its intended audience includes the government bodies, municipalities, urban planners, engineers, architects, civil servants, and citizens who are part of urban development, from initiation through implementation. The facts and findings presented herein are relevant to any national or international debate concerning urban development which aims to create sustainable, resource-efficient, and climate-sensitive urbanization processes. The text and visuals of this book are intended to serve as a comprehensive decision support tool, taking into account that future urban challenges and planning tasks can only be tackled through an interlinked and stakeholder driven iterative process.

As a result of the Young Cities research project, this book acts as a multilayered reference manual by providing: (a) a brief outline of the MENA region's urban challenges; (b) a proposal for generic principles and actions for creating an energy- and resource-efficient urban environment; (c) the opportunities and impacts of each discipline involved in an integrated planning process; and (d) the findings of the applied principles in the 35 ha Shahre Javan Community pilot project.

There is a broad range of publications and guidelines on sustainable urban development, including "Green Urbanism" (Lehmann 2010), "Ecological Urbanism" (Mostafavi and Doherty 2010), "Planning for Sustainable Cities" (UN-Habitat 2009), "Architecture for Rapid Change and Scarce Resources" (Sinha 2012), and "The Urban Transformation" (Sclar et al. 2013). This book provides a unique, solution-based perspective by drawing on lessons learned from the pilot project located within a New Town. Supported by an analytical approach, this book has the role of planners in mind while keeping a vision of the sustainable city of the future as its goal.

The findings in this book are valid not only for the context of medium sized cities, but for a broad range of city sizes, and even for their smallest complex urban units: their neighborhoods. In this sense the book addresses urban planning and development within a new town, a city extension, or as part of urban renewal in a megacity.

In a recent publication on city design, Barnett (2011) refers to city design challenges as being threefold: "the challenge of rapid urban change," climate change as a challenge to city design, and "failures of city design after 9/11." As part of addressing these challenges, this book seeks to focus on the integration of a broad variety of disciplines, actors, perspectives, and tools within the field of urban design.

The 35 ha "Shahre Javan Community" pilot project in Hashtgerd New Town, Iran was the focus of a seven year research process undertaken by an interdisciplinary team of German and Iranian research institutes, international researchers and PhD students as part of the "Young Cities" research project funded by the German Federal Ministry of Education and Research (BMBF). This book is the culmination of the pilot project's outcomes and the knowledge gained through Young Cities research.

The MENA region is experiencing rapid urbanization, making integrated solutions for promoting sustainable urban development crucial for the future. The urban challenges of MENA region countries share many commonalities despite the pronounced diversity in their cultural backgrounds, economic conditions, and social circumstances. Given this, the findings of the Shahre Javan Community pilot project can feasibly be scaled up and applied to the broader region, and the results detailed in this book are framed to take advantage of this potential. By doing so, the authors hope to spark lively discussion around future urbanization processes in one of the world's most rapidly urbanizing regions.

In sum, this book should serve as inspiration and catalyst for further research, for the development of regional and national programs for neighborhood based energy-efficient urban development, and as a contribution to the international debate around the future challenges of an urbanizing world.

Megacities research has been defined by a strong analytical approach. One of the most read publications on megacities worldwide, edited by Bujis, Tan, and Tunas (2010), includes a chapter on "Designing Megacities". In an attempt to address what Bujis, Tan, and Tunas highlighted as the "goal of not repeating history's mistakes" (p. 317), this book strives to consider the role of architects in planning within the context of nature.

Finally, this publication stresses the responsibility of all humans to more thoughtfully care for limited natural resources and to more thoroughly consider the vulnerability of our planet.

How to Read the Book

Nadine Kuhla von Bergmann | Holger Ohlenburg

From the very beginning, it was the strong intention of the authors to present a publication attractive to readers from a variety of backgrounds with differing time constraints for accessing the knowledge herein. Thus, the chapters are formatted to provide easy access to varying levels of information depending on a reader's time or interest. The general scope of each chapter is summarized below. For fast readers pursuing a general overview, we suggest focusing on the *key messages and headlines* to grasp the overall challenges and principles. *References* provide for further reading in instances where more information is necessary. The text *quotes* are selected to back-up and highlight the challenges and principles while also providing the reader with links to relevant literature. *Case studies, maps, and diagrams* provide further illustration and information.

The first four chapters (I–IV) give an overview of the MENA region and its current and future challenges and opportunities given the aim of a resource-efficient and climate-sensitive urban development. *Chapter V and VI* provide further information, specific to the Shahre Javan Community pilot project in Hashtgerd New Town, Iran but with wider applicability.

Chapter I summarizes information on the diverse countries located in the MENA region. The aspects discussed reflect all of the MENA region countries and are closely related to current and future urban challenges. The facts and figures presented in this chapter describe the rapid urbanization, current demographics, social contexts, energy consumption profiles, and future role of renewable energies, climate trends, water resources, and environmental perspectives.

Chapter II summarizes the main challenges of the urbanizing MENA region with a focus on urban infrastructures, including: housing, transport, energy demand, water scarcity and quality, waste water management, air pollution, coastal environmental degradation, waste management, and governance.

Chapter III presents the vision and principles for developing resource-efficient and climate-sensitive urban design in the MENA region as set out in the context of the Young Cities research project. **Urban Form**, **Urban Resources**, **Urban Technologies**, and **Urban Governance** are introduced as key aspects of an integrative urban design process involving a variety of planning disciplines. The key aspects are set in four different colors—colors which are also used for the highlighting of the key aspects' content in Chapters IV and VI.

Chapter IV delves into a deeper description of the parameters and key aspects crucial for the successful implementation of the visions and principles elaborated in Chapter III. Each planning discipline involved in the Young Cities research project contributes a subchapter elaborating approaches and solutions for various scales (e.g. architecture, urban planning) and sectors (e.g. energy, water, transport, and landscape planning) and their impacts on the key aspects introduced in Chapter III. Additional sub-chapters are presented for Environmental Assessment, citizen participation, and assessing and monitoring neighborhood sustainability.

Chapter V frames the context of the Young Cities as a project in the vicinity of Tehran, Iran. It describes Iran's: urbanization processes; demographic, social, and economic conditions; aspects of energy consumption; availability and usage of natural resources; and land use as well as Iran's national regulations for saving energy.

Chapter VI concentrates on the approaches of resource-efficient and climate-sensitive urban design applied to the Shahre Javan Community pilot project in Hashtgerd New Town, Iran. After a general description of the case study's settings, Section 1 focuses on the integrated planning and research process and Section 2 briefly summarizes the case study results. Both sections function as a framework for the subsequent sections, authored by the Young Cities research team's participating disciplines. Each section details the steps and measures the discipline undertook in developing their neighborhood design solutions for the Shahre Javan Community.

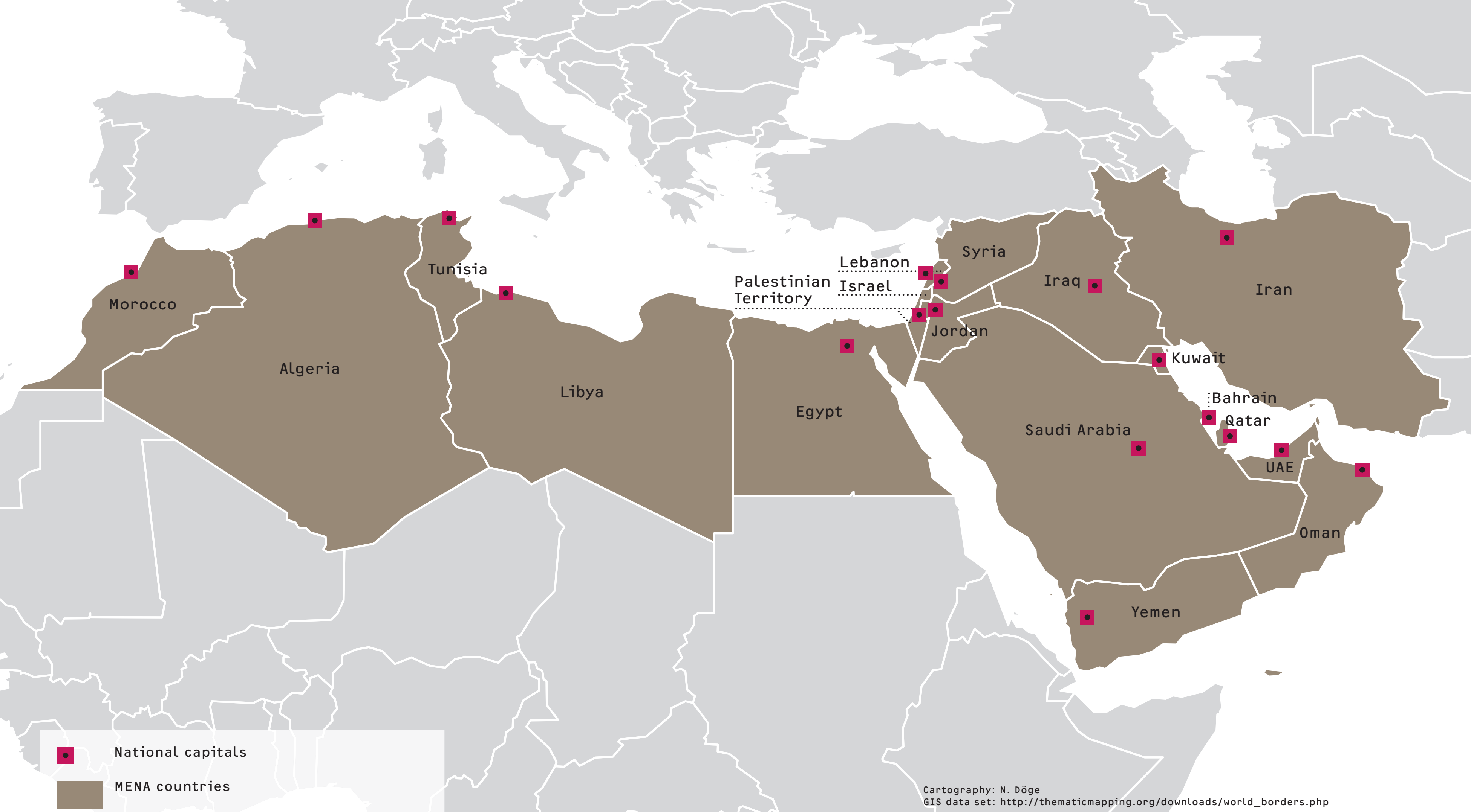
The publication concludes with *Chapter VII*, a résumé and a list of key principles for energy-efficient and climate-sensitive design for the MENA region.

I

Profile of the MENA Region

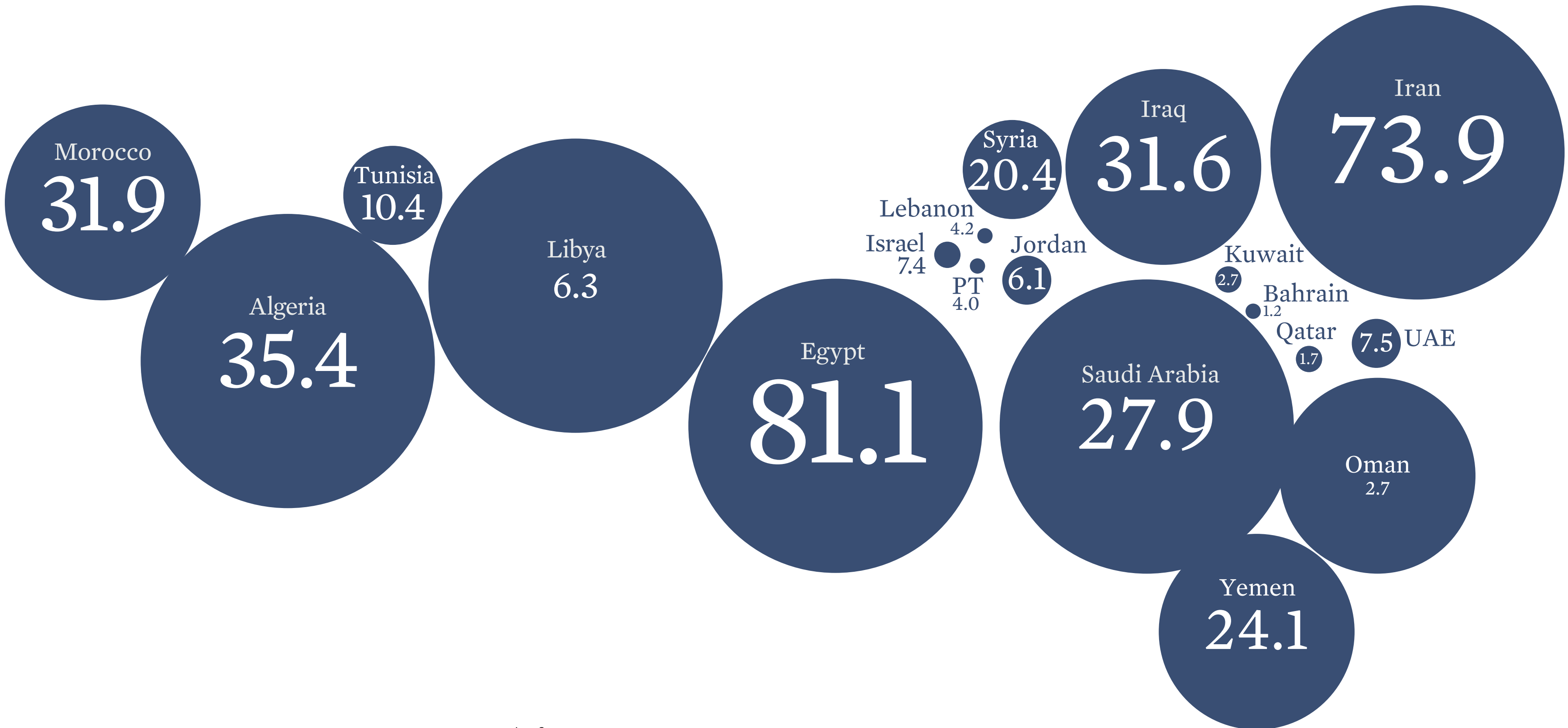
This chapter summarizes information on the diverse countries located in the MENA region. The aspects discussed reflect all of the MENA region countries and are closely related to current and future urban challenges. The facts and figures presented in this chapter describe the rapid urbanization, current demographics, social contexts, energy consumption profiles, and future role of renewable energies, climate trends, water resources, and environmental perspectives.

1 The MENA Region



The MENA region as defined in this publication is a vast area stretching about 7,500 km from the High Atlas in Morocco at its western edge, to the Koppeh Dagh in Iran at its eastern edge, and 3,000 km from Yemen's Hadhramaut in the south, to Turkey's Pontic Mountains in the north. It extends over three continental plates: the African, Arabian and Eurasian Plate. The commonly accepted definition of the MENA region encompasses 19 countries, which are located in North Africa and the Middle East.

In 2010, the population of the entire MENA region was 380 million people, of which 165 million resided in North Africa and 215 million in the Middle East. The region has a wide variety of country sizes and populations. It includes very small countries, such as Bahrain with only 1.2 million inhabitants, as well as very large countries, such as Egypt with over 80 million inhabitants. While geographic location, cultural aspects, and climatic character (mostly arid) differ across the region, the various populations have developed and adopted a wide range of living and subsistence strategies. As a result, the urban population concentrates mainly along coastal or river shores and the region's historic trade routes. The rural populations are either settled, with an agrarian economy, or unsettled, with a mobile livestock-keeping and trade based economy.



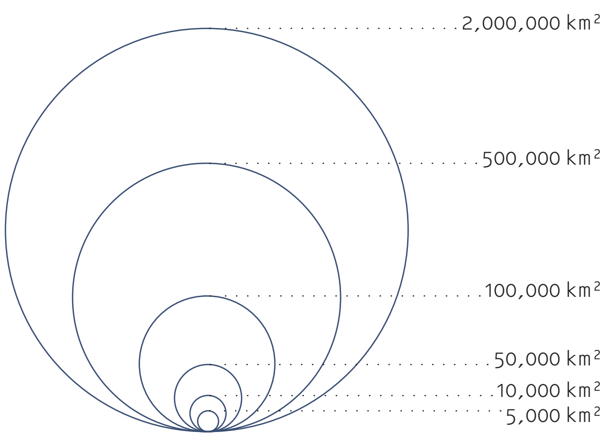
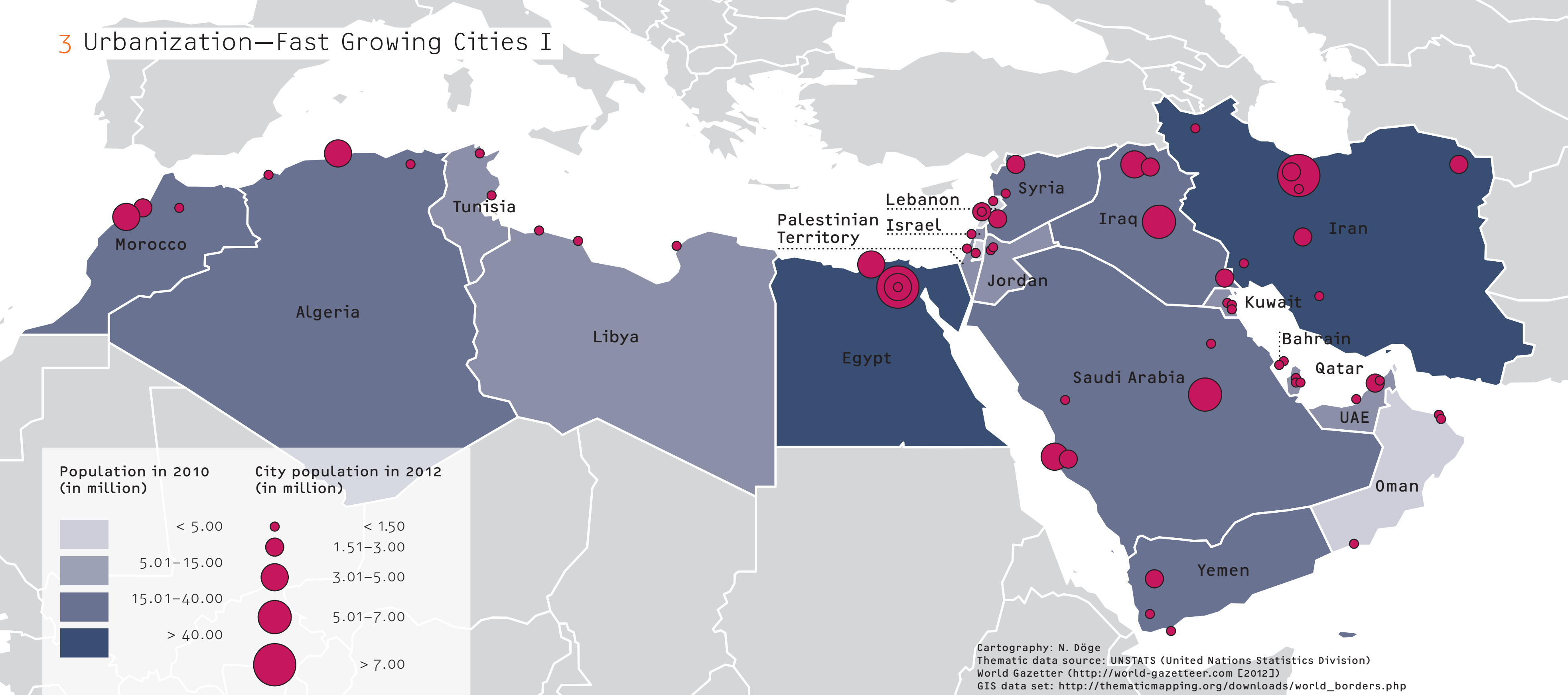


Fig. 1: Total area and population of MENA countries in 2010 (based on data from UN 2012)

Population in millions as numbers in the bubbles, land in km² as bubble sizes

3 Urbanization—Fast Growing Cities I



"The urban setting is under extreme pressure in MENA today, as a result of a very rapid urbanization rate over the past 10 years. Out of a population of 300 million, 170 million reside in urban areas and according to UN projections the MENA population will reach 430 million by 2020, of which 280 million are expected to be urban. That is an urban population increase of over 65%, compared to the projected rural population increase of 8.5%."

(The World Bank 2008a)

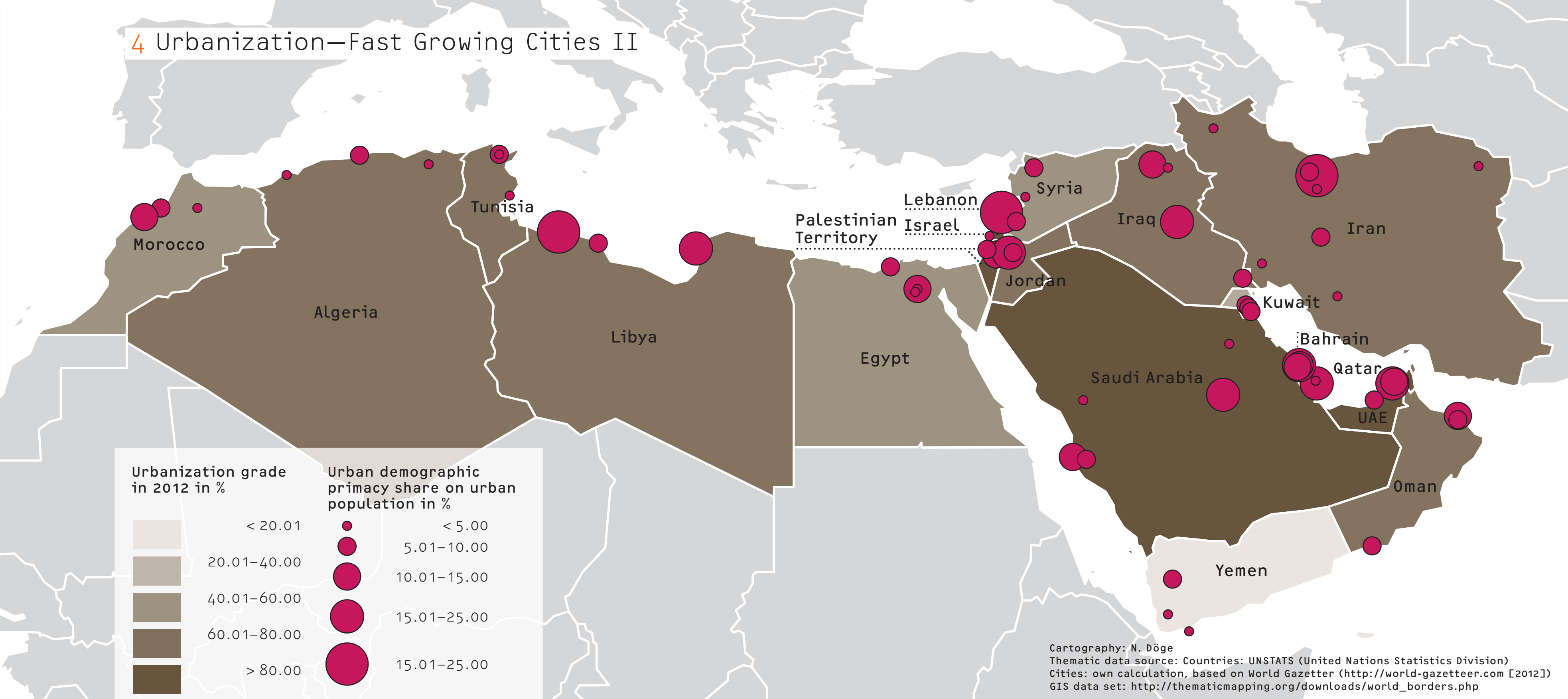
According to Bähr (1997), societies of developing countries face four different phases of movement during their development: (1) Rural to urban migration, (2) Emigration, (3) City to city movement, and (4) Other spatial movement. The 1st and 3rd phase paired with the process of demographic transition are the main drivers of urbanization (cp. Chapter on Demographic Development). When applied to the worldwide characteristics of urban growth that are presented in the State of the World's Cities 2008/2009 report (UN-Habitat 2008) it is possible to differentiate three phases of rapid urban growth:

- Phase 1 Mostly rural to urban migration,
- Phase 2 Mostly natural inner city population growth, and
- Phase 3 Mostly city to city migration.

In the MENA region, large, ancient agglomerations have existed for thousands of years. Since 1950, the region has experienced rapid urbanization due to the combination of population growth and migration processes. Over the last 60 years the population in the MENA region increased from around 82 million to the 380 million people of today (UN 2011). Within the past few decades, the MENA region has been one of the fastest urbanizing regions in the world (The World Bank 2005). The urban population's share of total population grew from only 28% in 1950, to 62% in 2010, and will achieve 70% in 2050 (UN 2011). The reasons for this rapid urbanization are substantial rural to urban migration, high fertility rates in combination with improved health care systems, international immigration, and migration due to national and international wars and conflicts (El-Batran 2008).

There are regional differences in urbanization; most of the MENA countries have already reached a high grade of urbanization (> 50%) and the importance of rural to urban migration is becoming less prevalent (see also map on the next page). Prime examples are countries such as Lebanon, the UAE, and Qatar (UN-Habitat 2012a, p. 3f.). In the future, only moderately urbanized countries, such as Egypt, Morocco, and Yemen, as well as those with political conflicts, can expect to see notable migration flows towards urban agglomerations.

4 Urbanization—Fast Growing Cities II



"Two decades ago, only 30 percent of the population lived in cities. By 2020 an estimated 70 percent of the region's population will be urban, an additional 86 million people."

(The World Bank 2009)

Following the concept of Bronger (1993), primary cities stand above their nation's other cities demographically, functionally, and internationally and, thus, usually experience the largest migration surpluses. This has been the case in those MENA countries which have one main city, such as Egypt's Cairo, Tunisia's Tunis, or Libya's Tripoli. Exceptions have been countries with older urban systems, such as Iran or Syria. Today, it is secondary cities (with populations < 200,000 inhabitants) which are experiencing the fastest rate of growth (UN-Habitat 2012a, p. VIII). As a consequence, some MENA country governments have launched planning programs for secondary cities and satellite locations, such as the New Town programs of Egypt, Iran, Morocco, and Algeria.

Economic growth and urbanisation are inevitably linked to each other. It can be seen that economically successful regions are usually more urbanized than other regions but it still remains unclear whether or not urbanization directly impacts a region's economic growth (UN-Habitat 2008, p. 7).

Rapid urbanization not only puts pressure on the social and technical infrastructures of the cities, but is also accompanied by environmental degradation and large social challenges, such as a lack of affordable housing. In Egypt, Iraq, Morocco, Saudi-Arabia, Bahrain, and UAE more than 3.5 million dwellings are missing (Jones Lang Lasalle 2011, p. 3).

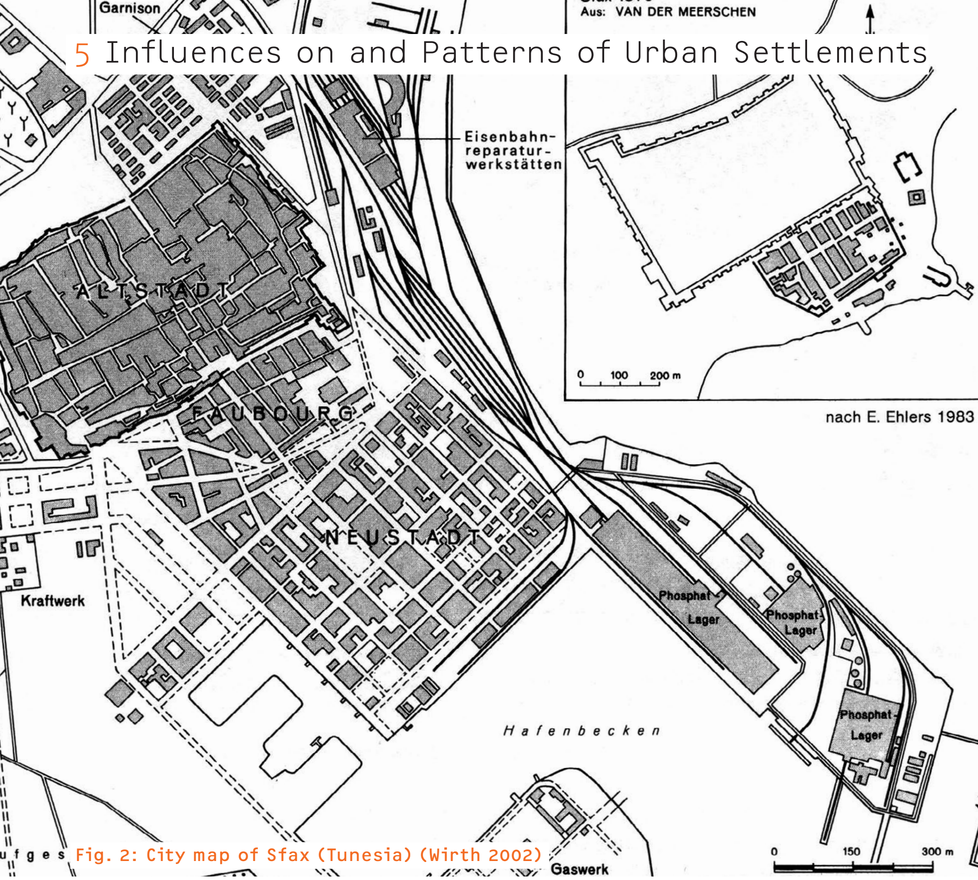


Fig. 2: City map of Sfax (Tunesia) (Wirth 2002)

Fig. 3: City map of Algier in 1867 (Wirth 2002)

The creation and reproduction of the city under Modernist planning theory, based on urban functional segregation, private car orientation and low-density spatial layouts became the norm almost worldwide, pushed further by imported concepts of zoning, satellite towns and mega-projects. With its rampant land speculation, convenient desert hinterlands and the resulting sprawl, today's Arab city has become a horizontal one, apparently without spatial expansion limits."

(UN-Habitat 2012a, p. 99)

Analyzing the MENA's urbanization process and comparing it to other world regions makes it clear that the region is characterized by a few unique aspects borne of shared historical backgrounds and cultural influences.

First, the region shares a very long tradition of urban settlements, including some of the world's first human settlements such as the village of Ur founded in Iraq in 4,000 B.C., cities of ancient Egypt, such as Heracleion, and of the Roman Empire, such as El Djem.

The conquest of the cities of the orient by Alexander the Great (334–331 B.C.) initiated a new, almost thousand-year-era of Hellenistic, then Roman, and later Byzantine culture. During the Hellenistic era cities were built or re-erected largely by rational planning methods. The strict North-South and East-West orientation, rectangular street grid, and distinct public spaces (Agora) were later reformed by Roman influences, but can still be traced in the urban plan of cities like Latakia, Aleppo, and Damaskus (Heinle 2009).

Hence, the monuments of the Roman Empire are still clearly visible throughout the entire MENA region. The most famous ruins can be found in Djerash (Jordan), Bosra (Syria), or Baalbek Lebanon). However, even cities, e.g. Damascus or Aleppo, that were continuously developed during the Islamic middle age still display Roman elements in their urban fabric (Burns 1999 and 2005, UNESCO 2012).

After the fall of the Roman Empire and with increasing Islamic influences, an era began which set the foundation for unique city patterns and urban settlements, such as the medinas of the cities of Fes, Aleppo, Isfahan, or Yazd. Those cities tend to be similar in their structural form and functions. The social and spatial order is expressed in the distinct hierarchical fabric of their residential buildings, which are arranged in concentric circles or districts around a centrally positioned mosque (Bianca 2000 and Ehlers & Floor 1993). Especially in Arab cities the city core ("medina") is surrounded by city walls with gates that connect it with the extra-mural urban areas. Another distinct element of this type city is the "suq"—a commercial and trading quarter. The complementarity between the mosque and the "suq" embodies the soul of the city (UN-Habitat 2012a).


Fig. 4


Fig. 5


Fig. 6


Fig. 7


Fig. 8


Fig. 9

Fig. 4: Ville Nouvelle in Casablanca, Morocco, 2012 (WANACU)
Fig. 5: Mudbrick-town Meybod in Iran, 2009 (Seelig)
Fig. 6: Informal housing in Cairo, 2012 (WANACU)
Fig. 7: Traditional residential architecture in Kashan, Iran, 2009 (Seelig)
Fig. 8: Modern and historical houses in the city of Aleppo, Syria, 2006 (Hebbo)
Fig. 9: Ancient clay houses in the oasis of Bahla in North Oman, 2012 (Janzen)

In the 19th century, many countries of the region were under foreign mandate or occupied by states of modern day's Europe, creating a strong western influence in their urban development. During the French mandate, new neighborhoods were constructed outside the historic centers of cities and were built in a European style. This western approach to urban planning and architecture can be found in modern buildings and urban projects of the region, for example, in the "Ville Nouvelles" of Fes or Rabat.

By the end of the 1950s, the last occupied countries of the MENA region became independent. Despite the different political systems of the following decades, ties to the western world remained and the "western style" paradigm continued to be used in planning. In some countries, new governments or planning departments were strained by massive population growth, resulting in both neighborhoods planned as large housing developments as well as completely unplanned housing agglomerations. In Egypt in 2009, nearly 20 million people, a quarter of Egypt's population, lived in heavily, socially—and spatially—segregated settlements (62% of the population in Cairo) (IRIN 2009, UN-Habitat 2012a). In Syria, approximately 38% of the country's population lives in informal settlements; within Aleppo, this number is 40% (2.4 million inhabitants in 2009) (Saad and Stellmach 2010; UN-Habitat 2012a). One explanation is that in most of the countries, planning and construction activities focused only on primary urban agglomeration areas or capital cities, while secondary cities were often marginalized.

Today, city structures throughout the region are characterized by a set of urban planning principles influenced by Islamic culture, early western and colonial practices, as well as by informal settlements created by decades of uncontrolled urban growth.

6 Demographic Development—A Population in Transition Cities

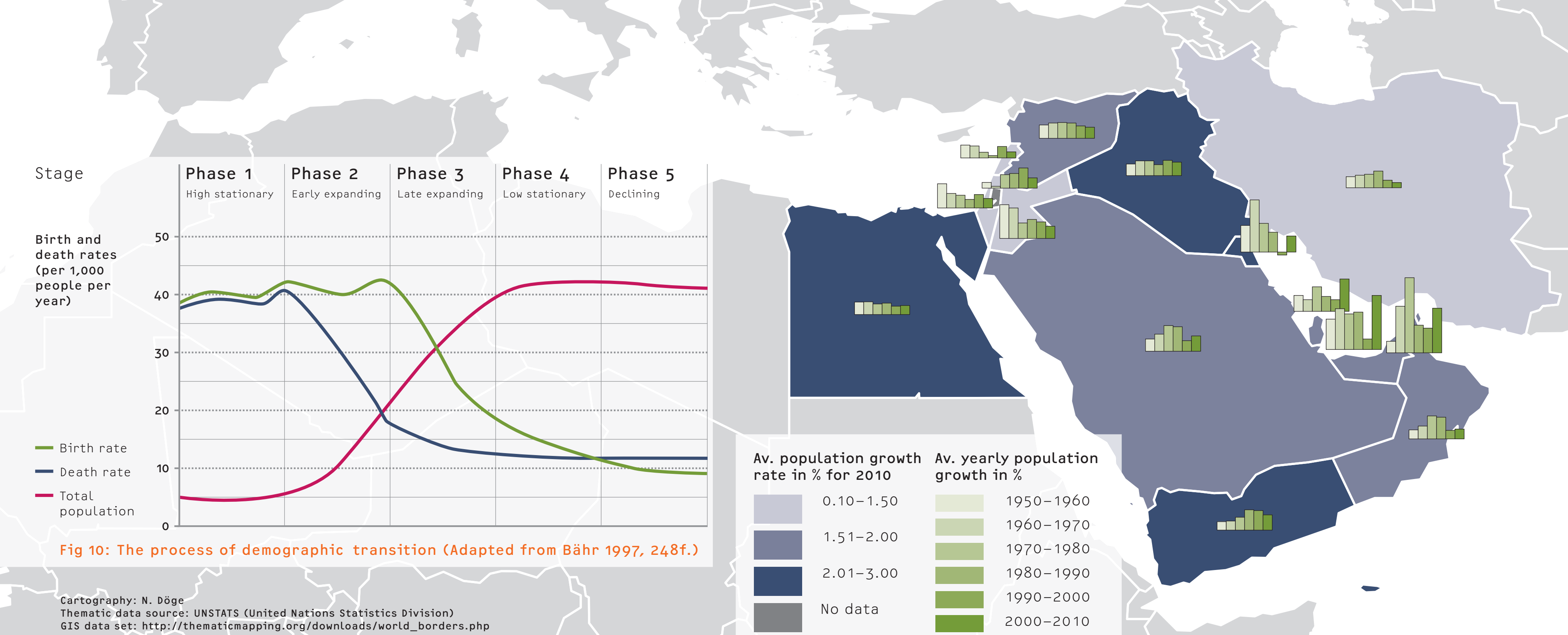


Fig 10: The process of demographic transition (Adapted from Bähr 1997, 248f.)

Cartography: N. Döge
Thematic data source: UNSTATS (United Nations Statistics Division)
GIS data set: http://thematicmapping.org/downloads/world_borders.php

"Nearly one in five people living in the Middle East and North Africa (MENA) region is between the ages of 15 and 24—the age group defined as 'youth.'"

(Assad and Roudi-Fahimi 2007, p. 1)

The demography of the MENA region is in transition. This demographic process is characterized by two phenomena: one spatial and one structural.

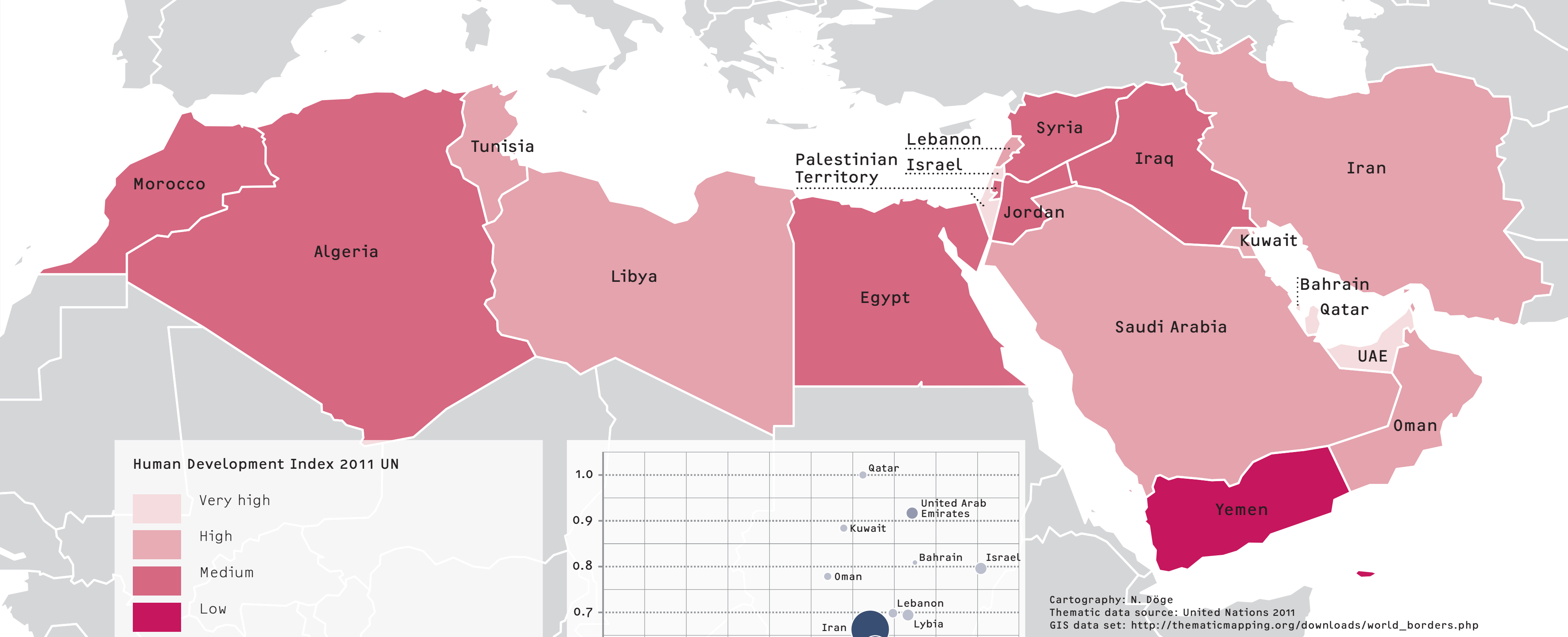
The first phenomenon, is characterized by a change in the spatial distribution of the population, mainly as result of rural to urban migration processes. In many countries of the region (cp. Chapter on fast growing cities), flows of refugees from political or ethnic conflicts as well as settlement programs for nomads and mobile livestock keepers are other important factors.

The second phenomenon can be described by the demographic transition model (DTM, see figure above): after the rapid population growth spurred by improved health care systems (phase 2), fertility rates drop and population growth slows (phase 3). Some MENA countries already show shrinking population growth rates (see map).

The different countries of the MENA region reflect different structural transition phases depending on their current stage of development. Each stage of transition faces individual challenges: in Yemen, for example, the population is in the early stages of the demographic transition (phase 2 of the DTM). With about 24 million people, 43% are between 0 and 14 years. The median age is only 18.1 years and the population growth rate is 2.5% (IndexMundi 2012).

Iran serves as an example of phase 3: after a dramatic increase in population in the second half of the 20th century, Iran has recently experienced a relatively sudden and dramatic drop in its fertility rate. The current demographic bulge in youth is a result of the former high birth rate. More than half of the population is under the age of 24, while one quarter is 15 years of age or younger (UNDP 2012a). The median age is 26.8 years and the population growth rate is 1.2% (IndexMundi 2012). The expected high proportion of the elderly will become a major challenge in the coming decades.

Another defining factor of the region's demography is the immigration of laborers into certain MENA countries—the strongest recent force being the oil economy, attracting large cohorts of guest workers into oil-producing countries such as the UAE, Qatar, Bahrain, and Saudi Arabia.



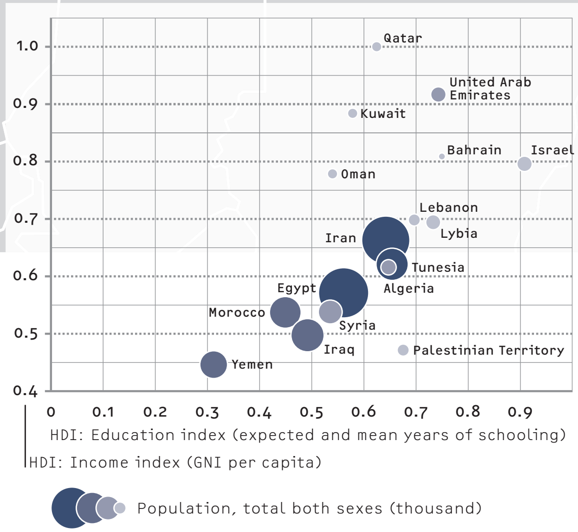


Fig. 11: HDI: Education Index for the MENA region

The Human Development Index (HDI) measures average achievements in three dimensions of human development: health, education, and living standards. Those three dimensions are calculated using the following factors:

- *Life expectancy (health),*
- *Mean years of schooling, expected years of schooling (education),*
- *Per capita gross national income (living standards).*

There are other indexes beyond the HDI which can draw a more precise picture of human development by certain aspects in specific countries, i.e. the "Inequality-adjusted HDI", the "Gender Inequality Index", or the "Multidimensional Poverty Index" (UNDP 2011).

The MENA region is often perceived as one homogeneous entity, although there are in fact major socio-economic differences. The most obvious difference is the income disparity between and within the countries; a circumstance which is in many cases directly caused by the unequal distribution of and access to natural resources. There is a number of relatively small oil rich countries with small populations and a high income per capita, such as Bahrain, Oman, Qatar, UAE, Saudi Arabia, and Libya. Larger countries with large populations but smaller, or no, fossil resources have far lower income levels; these include Egypt, Morocco, and Syria.

This leads to extensive inequality, with a high proportion of urban populations living below each country's designated poverty line (UN-Habitat 2012a). Despite the impressive urban growth of the 1990s and 2000s in countries like Jordan and Lebanon, the overall poverty ratio has declined slowly. As a result, MENA region countries have both low to medium Human Development Index levels, for Morocco, Egypt, and Yemen, and very high levels, such as in Libya, Iran, Saudi-Arabia, and the UAE.

Education and life expectancy vary strongly between the MENA countries. In general, countries in a later stage of urbanization and with greater available funds tend to have higher literacy rates and life expectancies, as well as lower child mortality rates. In this regard, Israel has a very high level of health and education development, along with the UAE, Brunei/Darussalam, Qatar, and Bahrain. In contrast, most of the countries with more land have lower literacy rates (Saudi Arabia at 86.1%; Tunisia at 77.6%) and higher child mortality rates (with 21 per 1,000 live births for both Tunisia and Saudi Arabia) (UNDP 2011).

8 Energy Consumption and CO_2 Emissions

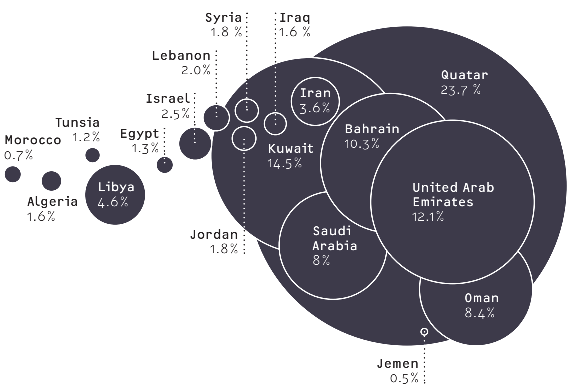
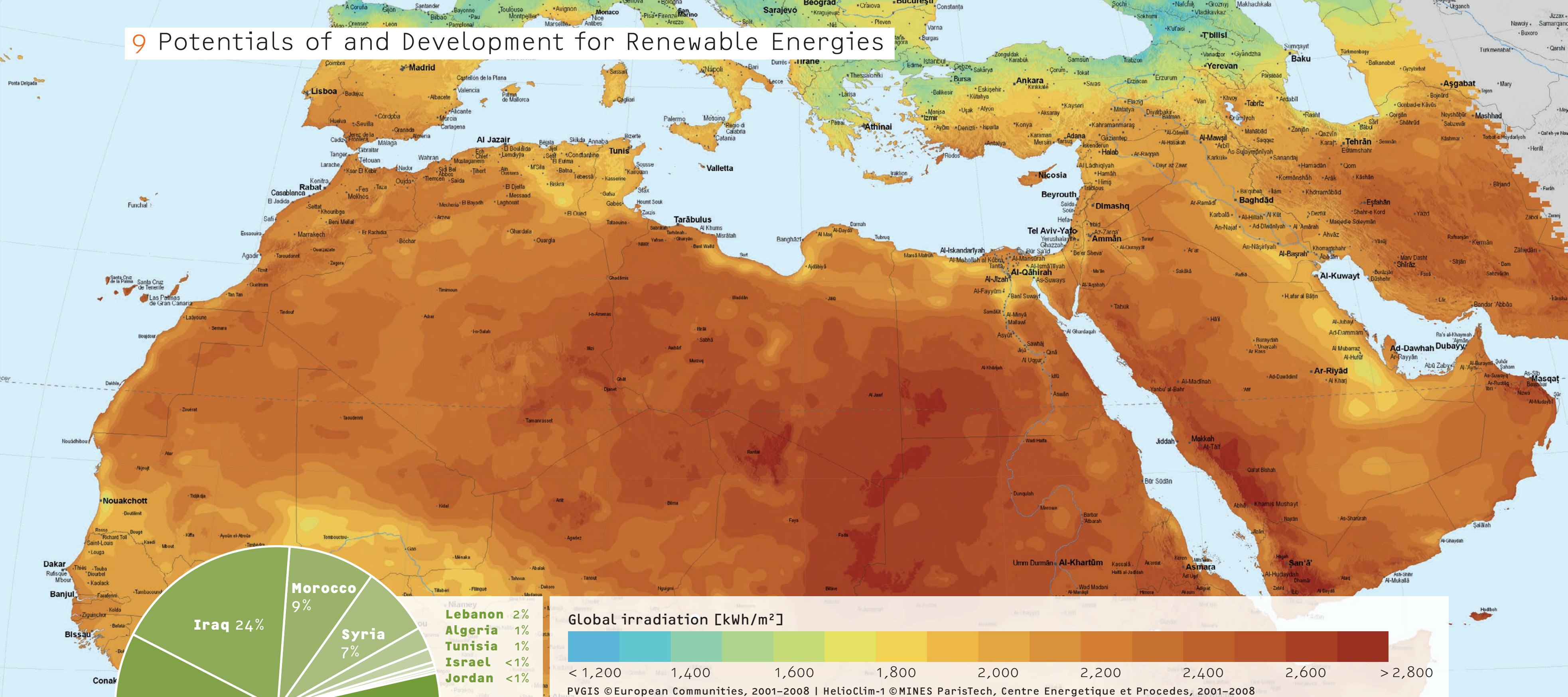


Fig. 12: Country share of the total MENA CO_2 emissions in 2008 (based on data from The World Bank 2012b).

Most of the electrical and thermal energy consumed worldwide comes from fossil resources. This is especially so in MENA countries where most of the oil and gas resources are located (Kuwait, Qatar, Saudi Arabia, and the UAE) and the gross domestic welfare system is based, to a high degree, on the oil producing sector (Belschner and Westphal 2012). In most countries where oil and gas resources are large, price distortions are considerable and cost recovery in electricity is low. Subsidized energy prices led to high energy consumption, severe environmental problems, and, thus, a rapidly increasing burden on government finances (Yamouri 2010). Nevertheless, in 2010 the population of MENA countries (6% of the world's population) consumed only around 6% of worldwide primary energy, while Europe's population (10% of the world's population) consumed nearly 24% (Eurostat 2012; The World Bank 2012b). On the other hand, in 2011, consumption in the MENA region rose about 4%, due to significant improvement in living conditions, while in Europe, the energy consumption decreased slightly by 0.5%, probably influenced by the debt crisis (BP 2012).

The highest CO_2 emissions in the MENA region are sourced from oil-producing countries like Qatar, Kuwait, the UAE, Saudi Arabia, Bahrain, and Oman (together about 74% of the region's total emissions). In fact, some MENA countries have the world's largest growth of per capita carbon emissions (Arouri 2010). In contrast, countries like Morocco, Tunisia, and the Yemen have very low CO_2 emission rates.



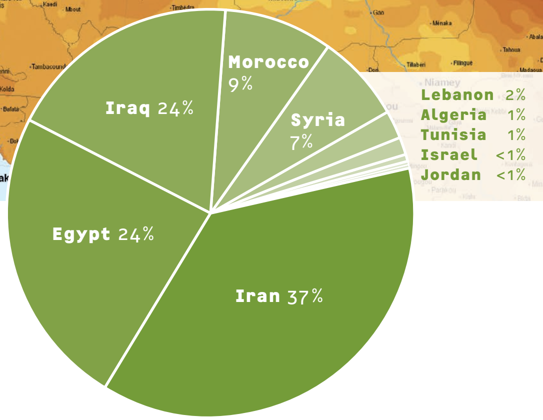


Fig. 13: Share of renewable energy generation in the MENA

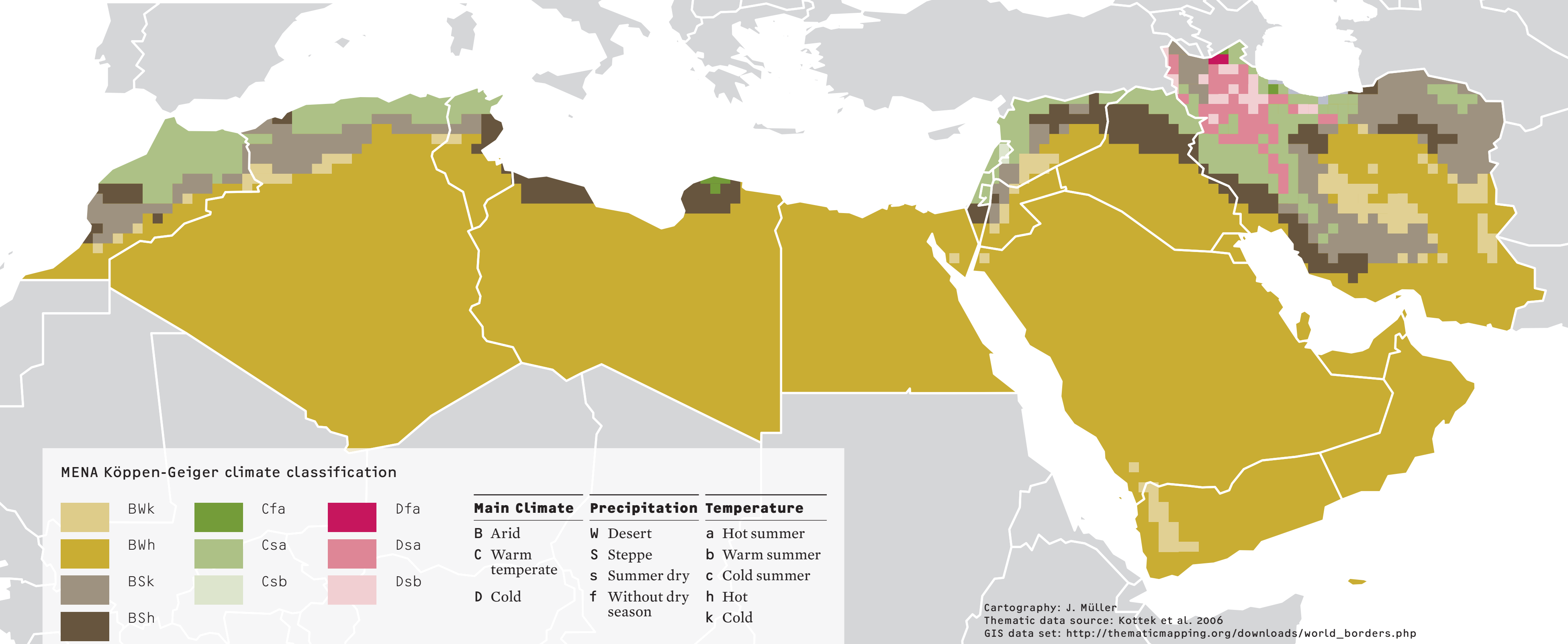
According to 2009 CIA World Factbook estimates, Iran, Iraq, and Egypt have the largest share of renewable energy generation in the MENA, followed by Morocco and Syria. The countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE, Yemen, and Libya are without renewable energy (CIA 2012).

The MENA region still meets 98% of its energy requirements through oil and gas, only a small part of energy is produced by hydroelectric plants or other renewable energy sources. This makes the average carbon intensity of the MENA region higher than that of industrialized countries. Nevertheless, attitudes are changing and awareness of climate change related issues is rising in the region. In 2012, the United Nations Framework Convention on Climate Change COP-18 took place in Doha, Qatar, marking an important milestone towards clean energy solutions both internationally and regionally (UNFCCC 2012). There is a recent shift towards “real price” policies to more accurately represent the true costs of energy, changing, as a consequence, energy consumption and the use of technologies for saving energy and reducing pollution (IZA 2012). Some countries have reduced or completely cut their fossil subsidies and are focusing on the renewable energy sector (UNDP 2012b). For example, in December 2010, Iran started a 5-year program to bring fossil fuel consumption subsidies for oil, natural gas, and electricity in line with international market prices. Their fossil subsidies have been reduced from about USD 80 billion in the year 2010, to USD 20–30 billion in 2011 (IEA 2012).

However, although the MENA region has some of the highest potential for energy in the world, only a handful of countries in the region currently have more or less concrete plans to push forward renewable energy production and use through subsidies or other policies (e.g. Egypt, Algeria, Bahrain, Jordan and the UAE) (UN-Habitat 2012a).

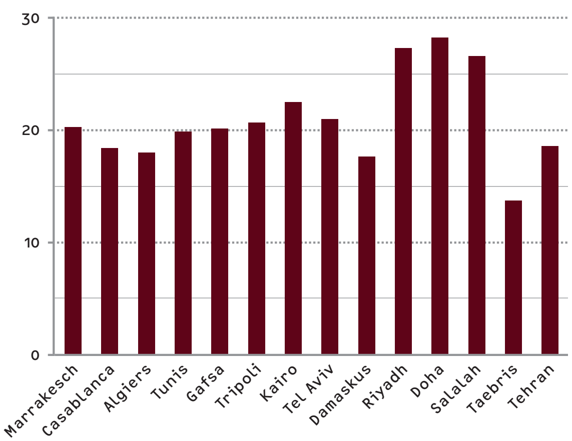
More prominent are international initiatives, such as the Word Bank Concentrated Solar Scale-up Program of building 20 GW of concentrated solar power by 2020, or the multi-billion dollar DESERTEC initiative which aims to build a network of solar and wind facilities throughout the MENA region. The intention is for clean energy to be transmitted to Europe, to support meeting commitments to reduce the Euro-carbon-footprint (UN-Habitat 2012a). If successful, these partnerships will also bring knowledge and technology into the region, increasing employment and contributing to the economies of the countries involved.

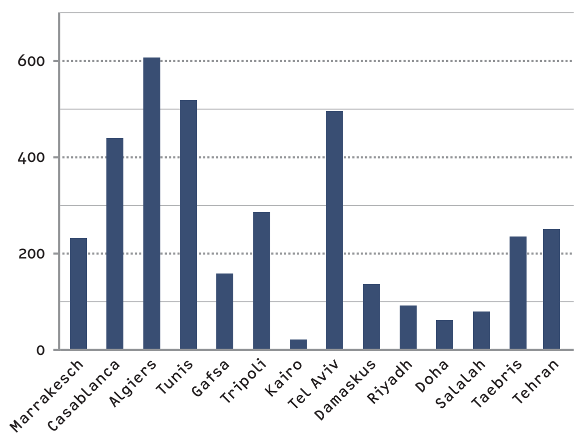
10 Variable Climate Conditions



Following the Köppen classification, as in the map above (cp. Köppen 1900), the climate in the MENA region is mainly arid, but there are also warm temperate regions and regions with cold climates.

Fig. 14, 15: Annual mean temperature (left) and precipitation in mm/year (right) in cities of the MENA region (based on DWD 1996–2010)



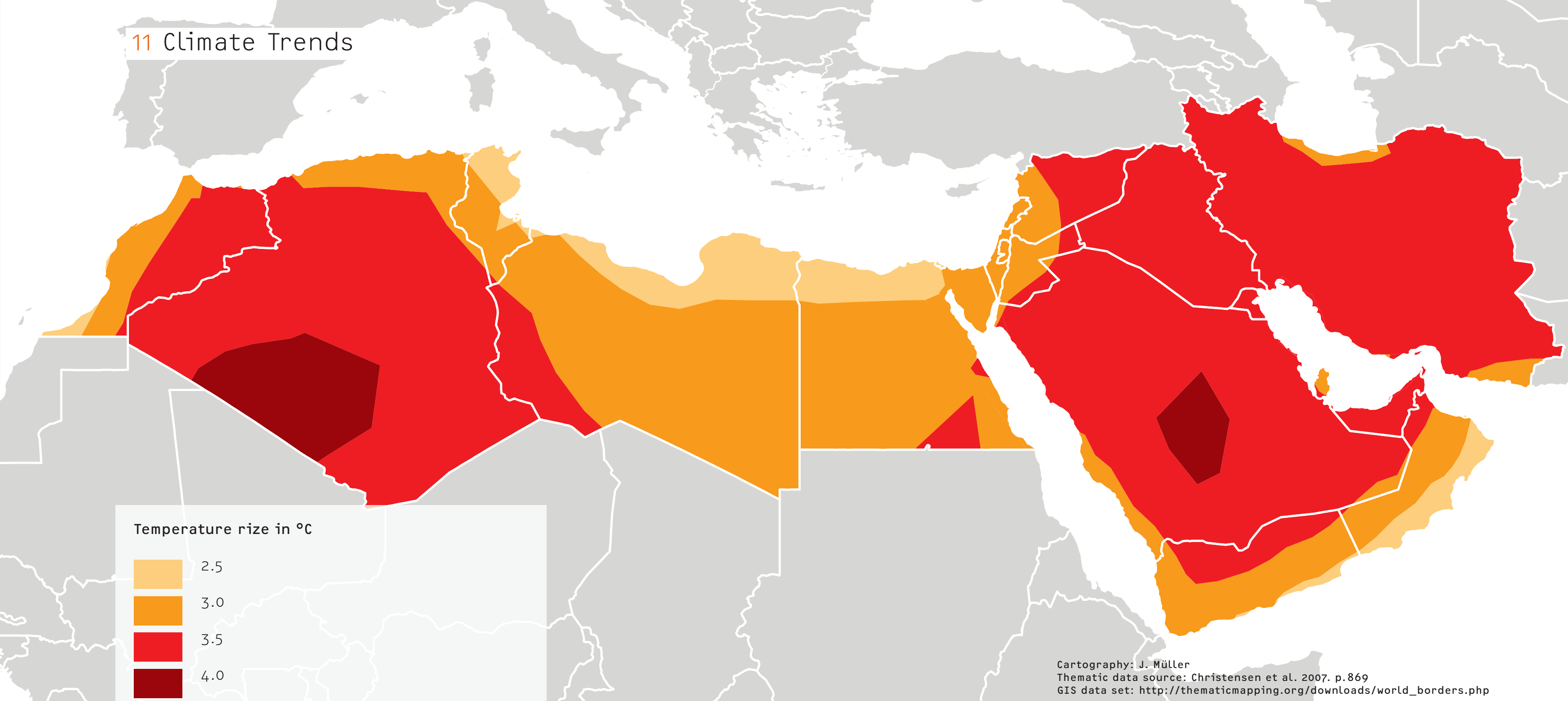


Almost 70% of the MENA region is characterized by an arid climate, nearly 30% by a warm temperate climate. However, the MENA region has a wide variety of climatic zones and shows great variability in both seasonal and annual precipitation, as well as in mean, maximum, and minimum temperatures.

The precipitation distribution varies significantly between cities of different countries, and even within a country. For example the mean annual precipitation ranges from 609 mm in Algiers (Algeria) to 20 mm in Cairo (Egypt) and in Tunisia from 519 mm along the coast (Tunis) to 157 mm inland (Gafsa) (DWD 1996–2010).

The same applies for the annual mean temperatures, which vary from over 30 °C in some cities of Saudi Arabia to under 14 °C in some cities of northern Iran. Even here we have significant variations within the countries themselves (e.g. Taebriz with 13.7 °C and Abadan with 26.0 °C in Iran (Ibid.)).

The variety becomes even more apparent in a comparison of mean temperatures with maximum and minimum temperatures. While Damascus and Algiers have similar mean annual temperatures (17.6 and 17.9 °C), the difference between mean annual maximum and minimum temperature is only 7 °C for Algier, but nearly 14 °C for Damascus (Müller 1983). Even Tehran and Casablanca have similar mean annual temperatures (about 18.5 °C), but there are extreme differences between the absolute maximum and minimum temperatures, e.g. Casablanca's 41 °C max./0 °C min. and Teheran's 42.8 °C max./20.6 °C min. (Ibid.).



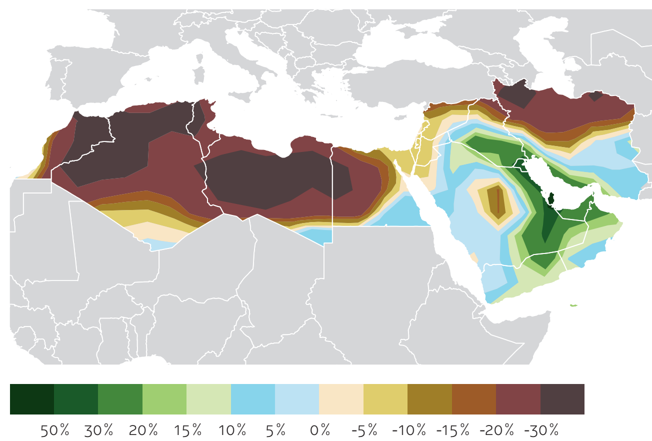
The maps show the predicted climate changes for the region between 1980–99 and 2080–99, averaged over 21 simulation models based on Christensen et al. (2007, Fig. 11.2 and 11.9).
Top: *Annual mean temperature changes.*
Right bottom: *Summer precipitation changes (JJA).*

According to simulations by the International Panel on Climate Change, temperatures for North of Africa and Central Asia are expected to increase by 3 to 4 °C from the 1980–99 average by 2080–99 (Christensen et al. 2007). The highest temperatures will occur in the summer months from June to August (JJA), as has happened in the past. Given these predictions, the region will likely have to cope with temperatures that are significantly above the global mean temperature increase.

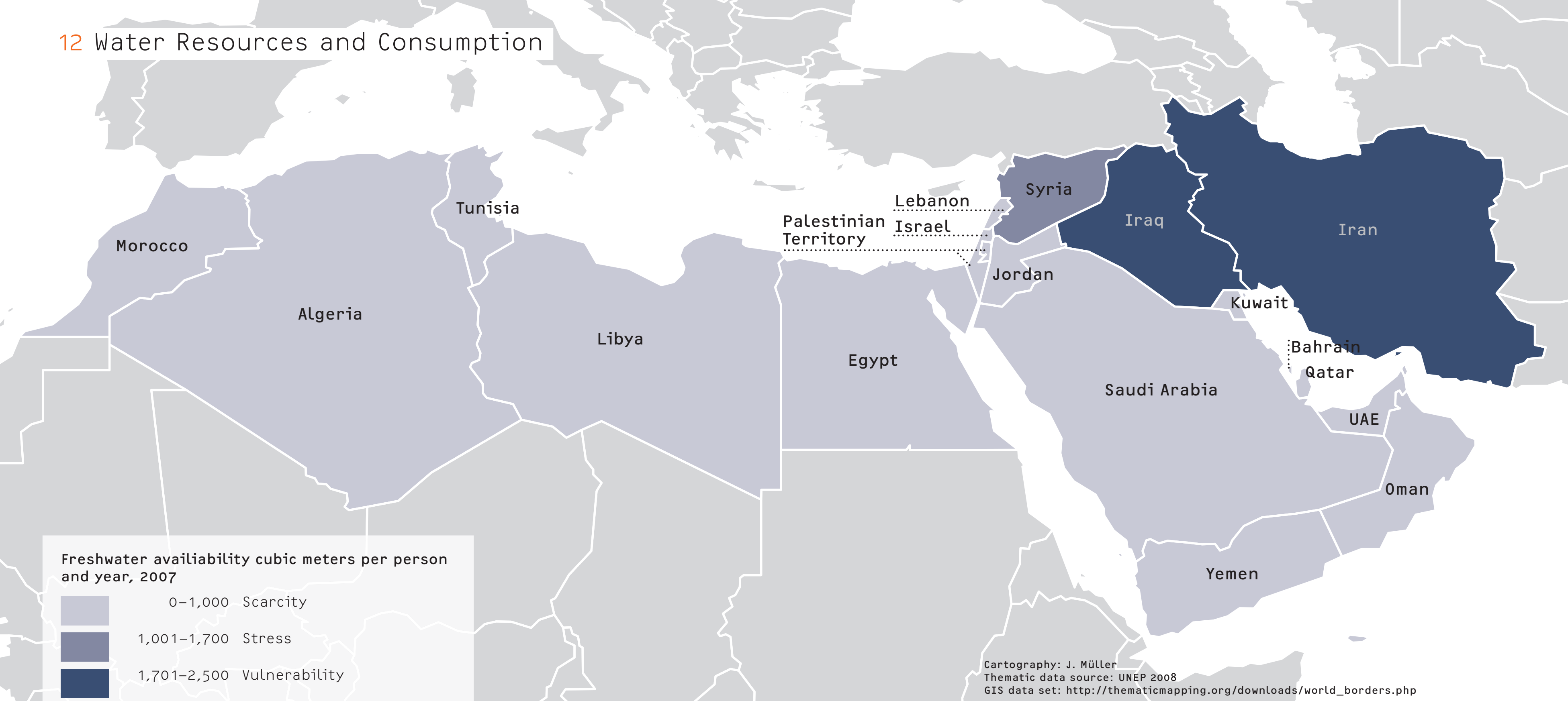
In addition to warming, North Africa will most likely experience a 20% decrease in mean precipitation by the end of the 21st century. This will be due to storm tracks shifting towards the poles, changing winter rain patterns in the region and concurrently decreasing summer moisture content of the region's soil.

In Central Asia the winter (DJF) will almost certainly become wetter, with 4% more precipitation, and the summer drier, with 13% less. In Iran, precipitation changes will be split, with northern parts facing significant decreases in summer while southern, coastal areas will face increased precipitation, and vice versa in winter.

Since simulation results vary strongly, great uncertainties remain in the predictions. E.g. the influence of vegetation and dust aerosol were not accounted for in the calculations, there is no realistic variability, and the simulations are said to have "significant systematic errors in and around Africa" (Christensen et al. 2007, p. 866).



12 Water Resources and Consumption



Within the MENA region, well adapted water saving technologies of water supply and distribution have been developed over the centuries. The "Qanats", for example, are huge subsurface canal systems for water distribution. However, valuable traditional knowledge and technologies are often inadequately considered in modern urban developments.

The MENA Region is one of the driest regions on earth. Due to a lack of natural water resources, water, particularly fresh water, is scarce. While the total rainfall in the MENA region is considerable, with an annual precipitation of more than 300 mm/y, it is largely limited to the Mediterranean coastal areas of Morocco, Algeria, and Tunisia, in Syria, Lebanon, and Israel, as well as the western mountains of Yemen and Iran. Only Iraq, Iran, Syria, and Lebanon can be considered well above the water poverty limit of 1,000 m³ renewable water resources annually, per capita. Other countries of MENA are considered water poor.

There are only a few major perennial rivers and lakes, namely the Euphrates and Tigris in Syria and Iraq, the Nile and Lake Nasser in Egypt, and some smaller rivers in Morocco, Tunisia, Libya, and Algeria. Some countries depend almost exclusively on freshwater resources entering the country from outside, as in Egypt, where the Nile river accounts for 97% of available freshwater (DLR 2007).There are some very large groundwater aquifers in the MENA region, which are recharged by rainfall and by incoming rivers. However, most of the water contained in subterranean basins is fossil water that is not renewed on an annual basis (cp. BGR & UNESCO 2006). Low water resources combined with high water withdrawal results in even greater water scarcity, creating additional conflict potential amongst MENA countries.

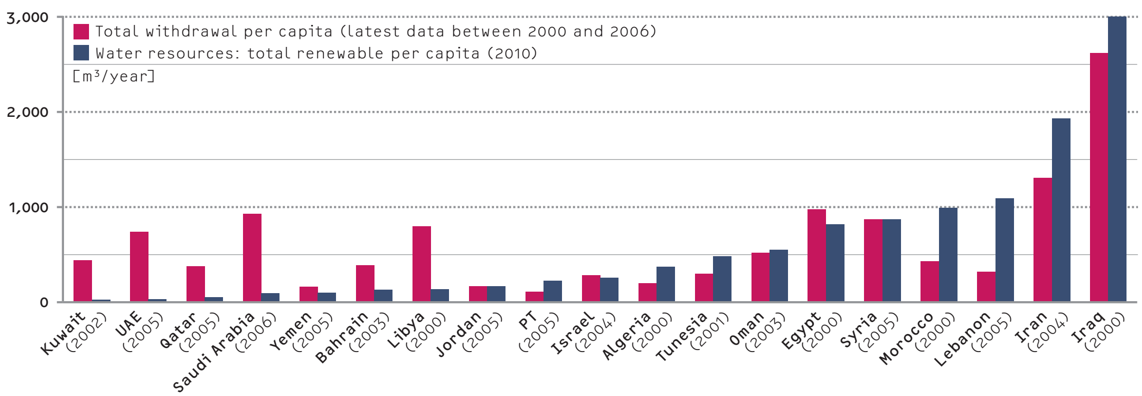
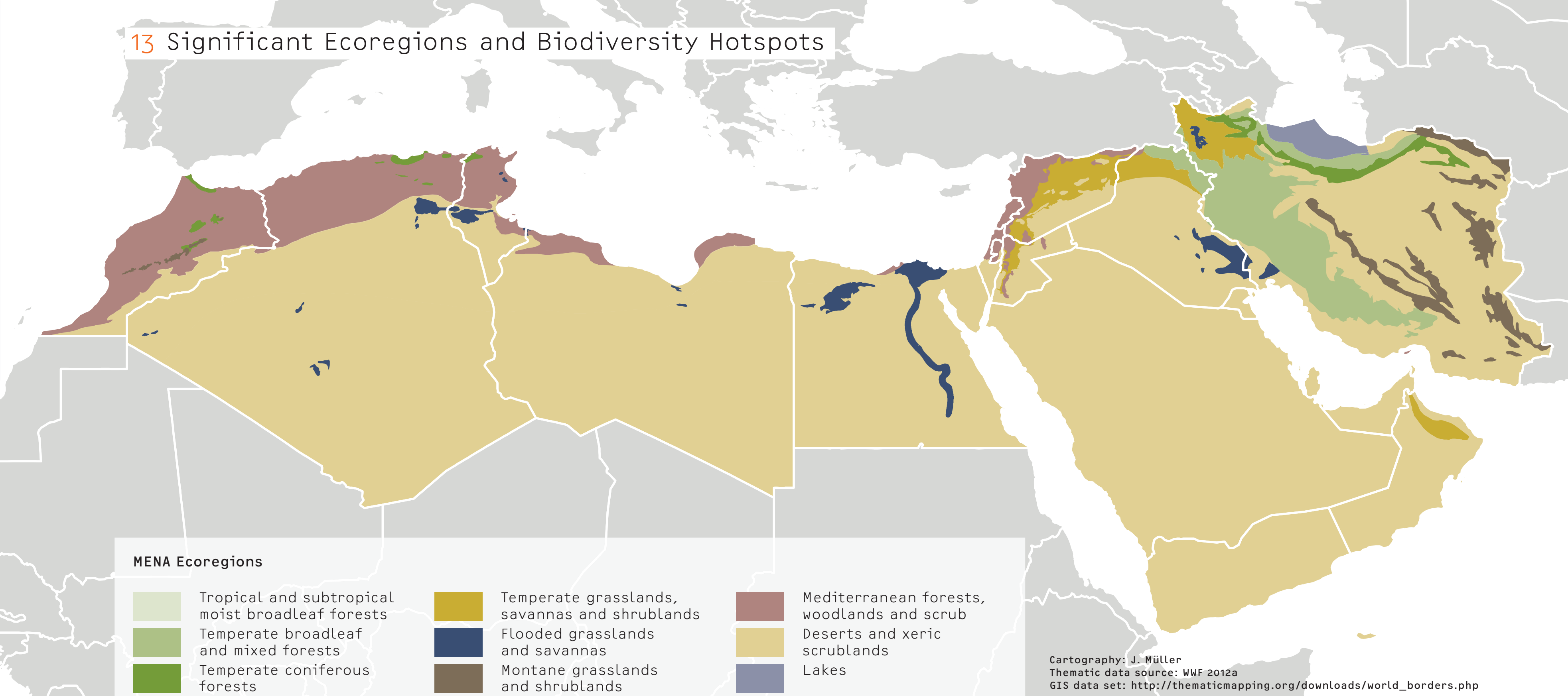


Fig. 16: Comparison of available water resources and withdrawal (based on data from FAO 2012)

13 Significant Ecoregions and Biodiversity Hotspots

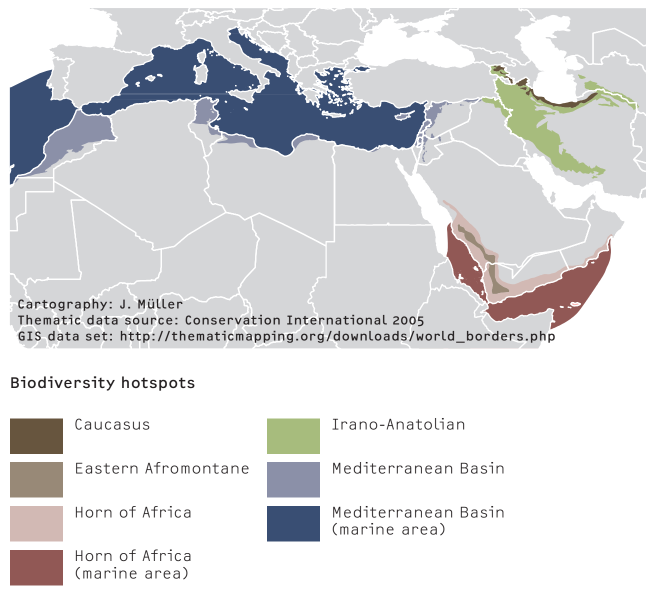


Biodiversity is not spread evenly across the Earth but follows complex patterns determined by climate, geology, and the evolutionary history of the planet. These patterns—called "ecoregions"—are large land or water units containing a geographically distinct assemblage of species, natural communities, and environmental conditions (WWF 2012b).

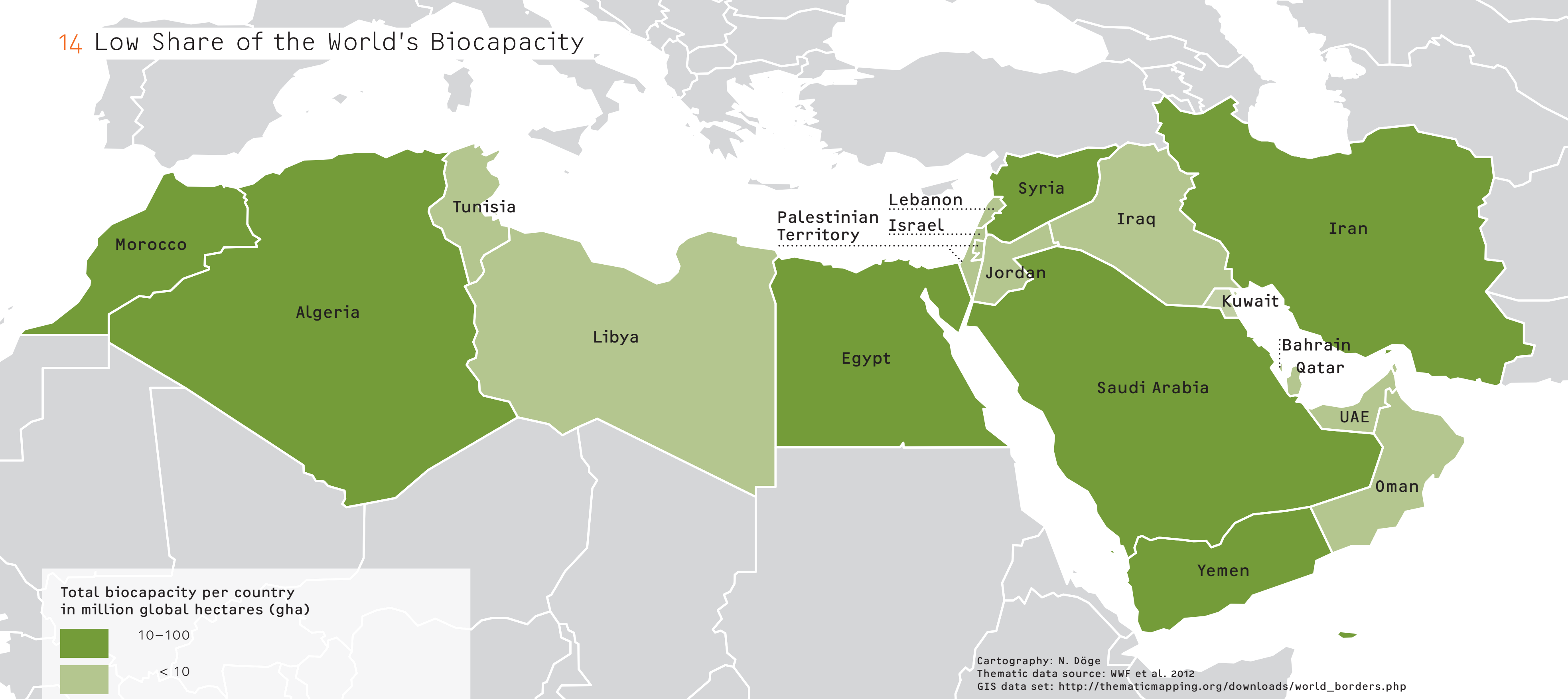
Although the greatest share of the MENA's land is desert and xeric shrub land, the MENA region represents a broad variety of the Earth' habitat types, enclosing seven of the world's fourteen ecoregions Three of the ecoregions are recognized as outstanding habitats for biodiversity: the Caucasus Anatolian-Hyrcanian Temperate Forests (classified as critical endangered); the Mediterranean Forests, Woodlands and Scrub; and the Arabian Highlands, Woodlands and Shrublands (classified as vulnerable).

Further, one freshwater and five outstanding marine ecoregions are adjacent to MENA countries, five of which have been classified as critical or endangered (Canary Current, Mediterranean Sea, Anatolian Freshwater, Mesopotamian Delta and Marshes, and Arabian Sea) and one as vulnerable (Red Sea) (Olson and Dinerstine 2007).

Conservation International has identified certain regions as biodiversity "hotspots" (see map below). Biodiversity hotspots are defined as habitats for especially high numbers of endemic species, which face extreme threats and have already lost at least 70% of their natural vegetation (Mittermeier et al. 2005).



14 Low Share of the World's Biocapacity



Biocapacity accounts for biologically productive areas and their productivity. Productive areas include: cropland, grazing land, fishing grounds, forests, and built-up land. Productivity depends on factors including: ecosystem type, management and health, agricultural practices, and climate conditions. Thus it can vary each year. Biocapacity is expressed in global hectares (gha), i.e. hectares with world average biological productivity (Global Footprint Network 2012b).

The MENA countries occupy an area of nearly 1,200 million hectares. In 2006, 35 million hectares of this were forest, 90 million hectares cropland, and 327 million hectares grazing land, while 13 million hectares were built infrastructure. The combined continental shelf area was 75 million hectares. The combined biocapacity of the region was 385 million global hectares, leading to an implied biocapacity per physical hectare of 0.32 gha (the world average is defined as 1). This number is indicative of the large areas in the region that are non-productive or have very low yields (Sakmar et al. 2011).

Almost all MENA countries have low biocapacities compared to the 2008 world average of 1.8 gha. However, biocapacity shares vary in each country of the MENA region. While some of the countries have high-share of fishing resources contributing to their biocapacity (Oman, Qatar, and even the UAE), others have a predominant share of cropland (50% of Egypt's, Syria's, and Tunisia's biocapacity), while others have considerable values in grazing land (Algeria, Libya, Morocco). Forests contribute only marginally to the biocapacity of MENA countries, due to arid climate conditions (see Fig. 17).

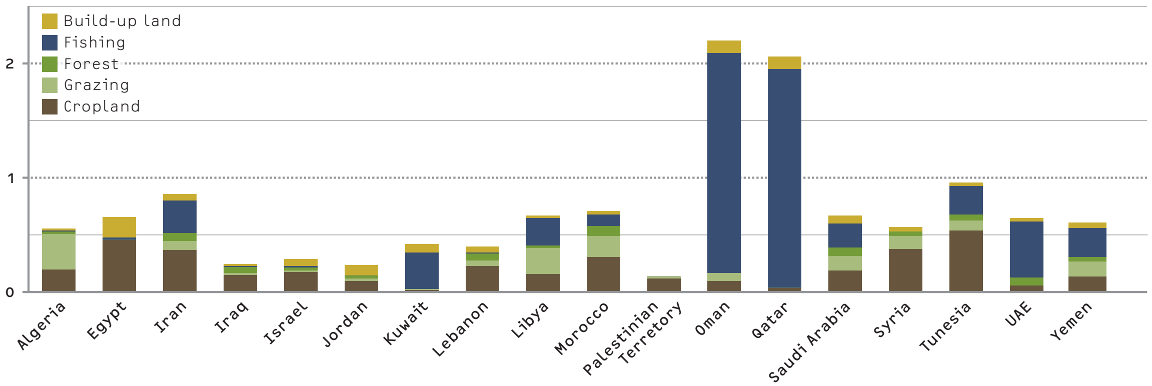
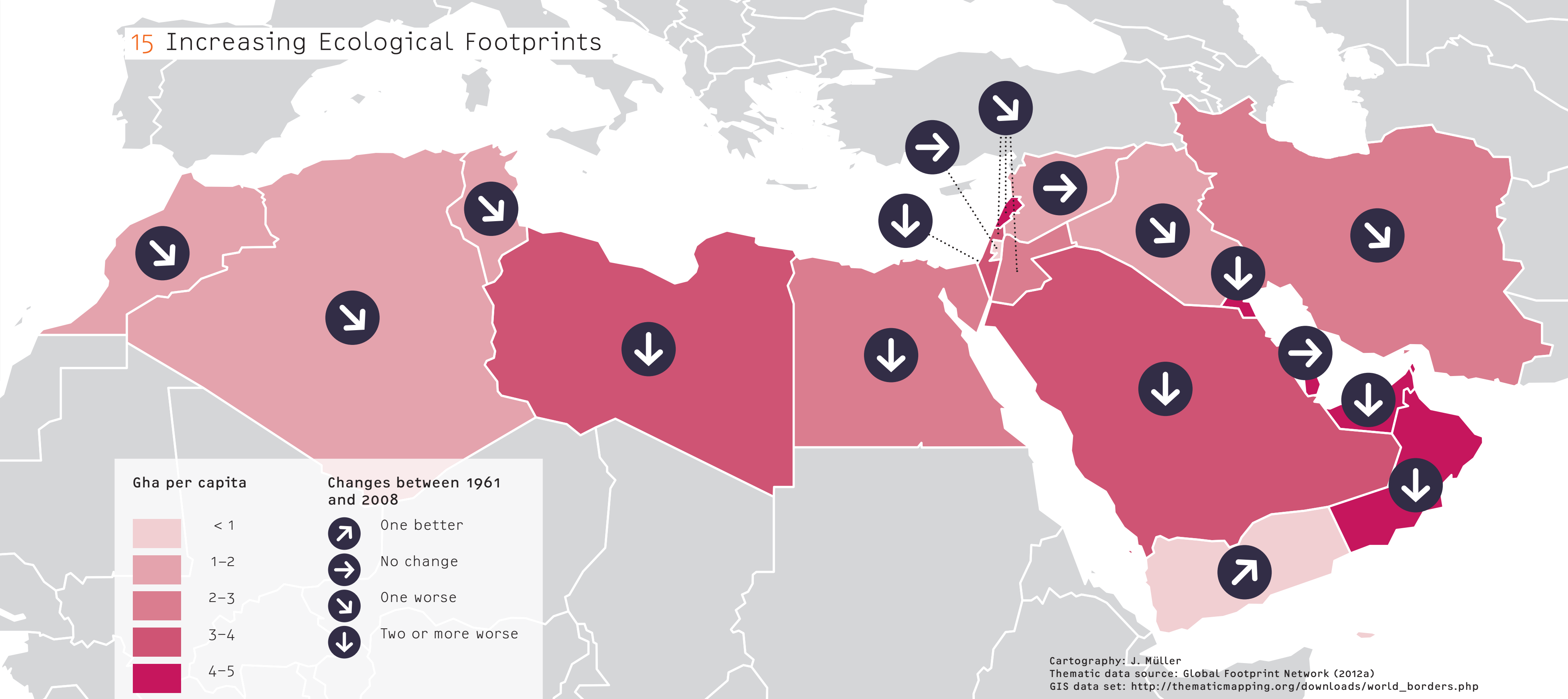


Fig. 17: Biocapacity 2012 per capita (based on Global Footprint Network 2012a)

15 Increasing Ecological Footprints



Cartography: J. Müller
Thematic data source: Global Footprint Network (2012a)
GIS data set: http://thematicmapping.org/downloads/world_borders.php

The Ecological Footprint is an accounting tool for measuring the amount of biologically productive land and water area which a country's population requires to produce the resources it consumes and absorb the waste it generates, using prevailing technology and resource management practices. The measurement unit is global hectares, as for biocapacity (see previous page), making data and results comparable (Global Footprint Network 2012b).

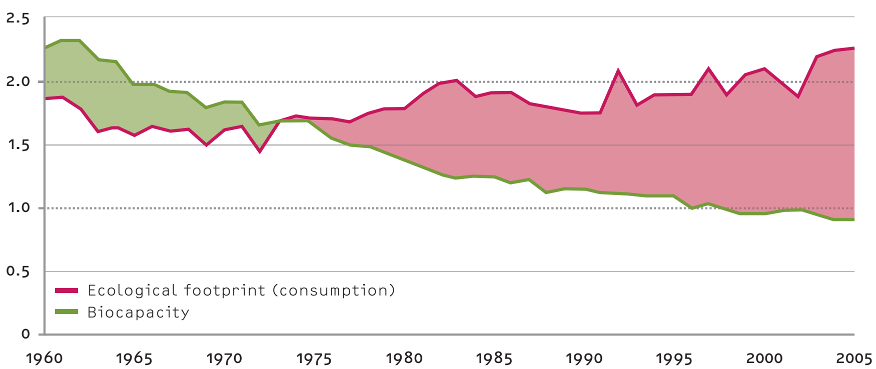


Fig. 18: The ecological footprint and biocapacity of the MENA region since 1960 (Adapted from Sakmar et al. 2011)

In spite of growing efficiency, humanity's pressure on ecological services and resources has significantly increased. This is certainly the case in the MENA region; today all MENA countries are "ecological debtors", in other words, they demand more of ecological assets than nature can provide. Only a few countries, Yemen, Qatar, Syria, and the Palestinian Territory, have reduced their Ecological Footprint or stayed constant with their impact of 50 years ago. Most show a significant increase, some of them have doubled or tripled their footprints in the past 50 years; the most severe of these are the UAE, Oman, and Egypt, but Libya, Israel, Saudi-Arabia and Lebanon are also of this group. Given this unfortunate reality, biocapacity has continuously decreased throughout the MENA region.

For example, in 2006 the MENA region's Ecological Footprint was 936 million gha, nearly two and a half times the region's biocapacity (incl. Turkey). Although the MENA region's per capita Ecological Footprint (2.2 gha) was smaller than the global average, it was larger than the global average available biocapacity, making the consumption of the MENA region unsustainable (Sakmar et al. 2011).

II

Challenges of an Urbanizing Region

During the last 20 years the cities of the MENA region have been confronted with drastic changes. As outlined in the previous chapter, these transformative processes are characterized by rapid urbanization, demographic shift, environmental degradation, rapid growth of individual motorization, social disparities, water scarcity, shifting climate conditions, and an increase in energy consumption and resulting CO_2 emissions. Most of these complex processes are related to each other and have significant impacts on cities and urban settlements of the MENA region. Through these conditions, it is clear that there is enormous pressure on the existing, and yet to be built, urban services and infrastructure systems, including energy, transport, water management, waste management, green spaces and urban governance. Thus, the way urban infrastructures are designed will define the city's capability to cope with future urban challenges. In this chapter a selection of urban challenges is sketched out in order to define the demands and needs of the MENA's urban future.

1 Urban Infrastructures

"The well-being of people in metropolises and their efficient management of natural resources based on sustainability principles, in particular in the context of urban infrastructures (energy, transportation, waste, water and wastewater), depend decisively on the use and management of certain technologies and techniques."

(Lehn and Kopfmüller 2009, p. 337)

Lack of basic urban infrastructures in Aleppo, Syria

In Aleppo, Syria approximately 40% of the city's population (2.4 million inhabitants in 2009) lived in informal settlements (Saad and Stellmach 2010; UN-Habitat 2012). Since Aleppo is one of the oldest continuously populated towns worldwide, today's city structure is an impressive combination and overlaying of different planning paradigms, as well as of partly uncontrolled urban growth. Although population growth is slowing down, in the next ten years the estimated growth rate will remain at 2.7%, a comparatively high level (Saad and Stellmach 2010). The result is a surprisingly compact city on the one hand, but on the other hand, an extremely fragmented one in terms of the socio-demographic distribution of its population and corresponding urban forms (Ibid.). Generally, there is a noticable gap in average incomes between the western part of the city and the eastern part of the city (incorporating all informal settlements and industrial areas) (Saad and Stellmach 2010; Hebbo 2010).

On one hand, basic urban infrastructures are insufficient throughout the whole city. There is lack of public places, green spaces, and public transport. Especially in informal settlements, urban infrastructures can be regarded as "weak", the lack of health and education infrastructures has been clas-

Fig. 19: New Towns development near Cairo, 2012 (Deter)

Fig. 20: Urban green infrastructure in Tehran (Young Cities Project)

Fig. 21: Single building in Qastal Harami neighborhood, Allepo's buffer zone between old and new city, 2006 (Hebbo)

sified as a serious future issue. On the other hand, the provision with goods and services at a neighborhood level is well distributed and has led to the development of different sub-centers within the city (Saad and Stellmach 2010).

Recently, new strategies for controlling urban growth are being developed, such as the "Master plan of 2009" and "Aleppo Diverse | Open City. An Urban Vision for the Year 2025". Although both identify and address serious problems, such as the legalization and upgrading of informal settlements, public transport systems, and green and open spaces, they do not address enough the other urban infrastructures.

Fig. 22: Traffic intersection in front of Presidential Palace in Heliopolis, Cairo 2012 (Deter)

Since the quality of urban life is determined by urban infrastructures (mobility, access to green and open spaces, water and food security, energy security and air pollution, waste management), the design of urban infrastructures is a crucial prerequisite for guaranteeing a functional and livable urban environment.

The term "urban infrastructures" is defined in various ways. The latest UN-Habitat report includes the following sectors as part of urban infrastructure: water and sanitation, power supply, transport networks and information and communication technologies (ICTs) (UN-Habitat 2012a). Other classifications differentiate by 'hard' and 'soft' infrastructures. The classification of the German Federal Ministry of Transport, Building, and Urban Development (2010) divides the social and technical infrastructures as shown in Table 1.

Urban infrastructures consist, on the one hand, of networks and systems which consume scarce natural resources (water, gas, oil, space etc.) and have an impact on the ecological footprint and CO_2 emissions of a city or region (mitigation ability). On the other hand, the way urban infrastructures are designed and developed determines the ability of an urban system to cope or buffer external effects e.g. weather extremes such as storms, draughts, etc. (adaptation ability). Therefore, urban infrastructures play a key role in confronting climate change as they directly influence the use of urban spaces and built structures, such as transport or energy systems, which then impact energy consumption and GHG emissions (TERI 2010).

The biggest challenge in terms of urbanization is the rapid expansion of urban space and infrastructure. As demands and needs change and rapidly increase, all municipalities of the MENA region are facing similar problems: the economic growth does not match the pace of expansion, and governmental authorities usually lack financial sources and manpower, as well as planning concepts and instruments (Kreibich et al. 2008). As a consequence, authorities lack capacities of steering complex city developments despite the implementation of adequate development frameworks for regulating infrastructure services, such as transport, water-wastewater, and electricity systems. This usually results in massive urban sprawl and informal urban developments, causing enormous spatial growth of urban settlements which are characterized by inefficient basic urban infrastructures such as water and energy supply (Ibid.).

Technical Infrastructure	**Social Infrastructure**
·· Transportation and Telecommunications	·· Education and Research
·· Fresh- and Wastewater	·· Health and Social Issues
·· Energy	·· Culture and Recreation (museums, urban green, etc.)
·· Shopping and Retail	·· Administration, Governmental Issues
·· Housing	

Tab. 1: Urban infrastructures (based on German Federal Ministry of Transport, Building, and Urban Development 2010)

Regional distinctions and main challenges

In the MENA region, one has to distinguish between the richer oil producing countries, mostly of the Organization of the Petroleum Exporting Countries (OPEC), and those with less economic power. While the OPECs were able to reinvest huge sums of their oil profits in the expansion of their cities and corresponding upgrades of their (often energy intensive) infrastructures, the countries with less economic power often lacked any ability to influence or steer rapid inland urbanization.

Moreover, due to political conflicts, proxy wars, and worldwide deflation of agriculture products over the last 30 years, most of the cities experienced an unexpected influx of new residents from the countryside (e.g. Iraq, Algeria) and devastated regions (e.g. Iran), requesting basic infrastructures such as shelter and basic daily needs.

Currently most of their cities are experiencing strong social-economic polarization, as well as initial fragmentation processes. Since most of the cities, especially along the coastline of the Mediterranean Sea, are of ancient origins, ruled by colonial, autocratic, or communist regimes during the last hundred years, the existing urban landscape was partially reshaped on the basis of planning paradigms that reflected political goals. The outcomes of these different planning eras are also often reflected in the socio-economic distribution of the population and form an additional challenge for the local authorities of today.

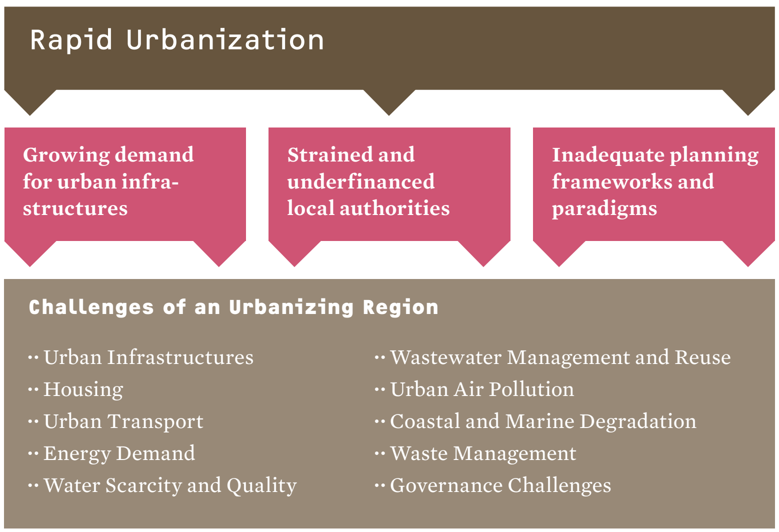


Fig. 23: Key issues which impact on urban challenges

Three key issues characterize the current situation:

1. Growing demand for urban infrastructures,
2. Strained and underfinanced local authorities,
3. Inadequate planning frameworks and paradigms.

In the non-OPEC cities, these key issues resulted in urban structures of loosely connected and inefficient infrastructure systems that are ill-connected and poorly managed. As a consequence, standards for a better quality of living can't be met.

This bears two main risks for future urban developments:

1. Self-organized local actors will fill these infrastructural gaps with their own means and, as an effect, authorities will not be able to control or steer the management of networks. This is already visible in Cairo, Aleppo, and Damascus.
   - These self-made infrastructures are often overstrained and only work on limited local scale (local electricity grid does not fit with the main grid carrying loads).
   - The installed structures are generally inefficient and outdated.
   - Local authorities are not able to maintain the network.
   - Local authorities are not able to estimate the true demand and thus to dimension future expansions in the right way.
2. Huge parts of the landscape are defined by unplanned land-use structures that are becoming permanent over time. A very famous example is the "Gecekondus" (built during the night) in Istanbul that are today a normal part of the urban landscape.
   - Inhabitants and companies are investing in these structures and consolidating them. Moreover, they lead to emotional bonding.
   - They are difficult to redevelop and to be subsequently equipped with infrastructures or to be re-used in a different way. Thus they are blocking any upgrade of urban infrastructures.
   - They are important economic drivers.

Tunisia's Success in Housing Development

Tunisia is one of the impressive examples of the MENA region where housing units have been created adequately to cater for the demand caused by the fast growing population (UN-Habitat 2011a, p. 25). Since the late 1970s Tunisia has improved living conditions for many people, seeking to integrate low-income urban areas into the urban fabrics. On the base of an effective institutional structure, (the Urban Rehabilitation and Renovation Agency (ARRU)) in 1981, which was supported by the government and international donors, around 25% of urban dwellers had benefited from these efforts by 2003. Between 2007 and 2012 two programs were established that aimed at improving living conditions for 26 and 56 neighborhoods respectively, reaching about 420,000 inhabitants.

These programs show that by urban upgrading and rehabilitation strategies, housing policies can act successfully. The UN-Habitat Report names Tunisia as "a leader in the MENA region in effective upgrading of slums, informal settlements and deteriorated city centers" (UN-Habitat 2011a, p. 22). The only criticism that remains is a lack of grass-roots community participation and the constant need for budgetary support from the government.

"Unless MENA's public and private sector leaders change their strategies, the growing crisis of affordable housing will become a major long-term problem that leads to widespread social dissatisfaction"

(Ernst and Young 2012, p. 1)

Fig. 24: Housing at the Nile river bank, Kairo 2013 (Hebbo)
Fig. 25: Old buildings at the edge of Aleppo's old city, 2006 (Hebbo)

Due to large demographic shifts creating a young population with declining household sizes, the MENA region is facing an unprecedented housing deficit. The urbanization rate averaged 80% (except for Egypt and Yemen at less than 50%) and caused the massive demand for affordable housing (The World Bank 2011). The deficit in affordable housing is an estimated 3.5 million units short throughout the region—a situation which will only worsen as demand continues to increase over the next five years.

Inhabitants of cities in Egypt, Iraq, Morocco, and Saudi Arabia suffer mostly from an insufficient supply of affordable housing. This development stems from a lack of access to affordable land, high capital costs associated with "big ticket" infrastructure (electricity, sewerage, etc.), low financial returns compared to other sectors of the residential market, and limited access to finance among low income households caused by an immature mortgage market (Jones et al. 2011).

Informal housing averages 20–40% in the MENA region, posing a major urban challenge as it increases both social segregation and environmental degradation (World Bank 2008). Rapid urbanization and inadequate provision of formal housing and urban infrastructure leads to vast informal settlements, slums, and shanty towns. The informal dwellings often go unacknowledged by official institutions, leaving them without technical or social infrastructure and lacking crucial public services. The self-help-solutions improvised by inhabitants often lead to environmental problems and leaves communities vulnerable to natural disasters and climate change impacts. It is only since the 1960s and 70s that attempts have been made to recognize a right to safe housing and infrastructure access and programs for the poor have begun, including housing programs throughout the region (Madbouly 2009, p. 49).

3 Urban Transport

"Ninety per cent of road traffic fatalities take place in low- and middle-income countries which, together, account for only 48 per cent of all registered vehicles. The World Health Organization predicts that such fatalities will be the fifth leading cause of deaths worldwide by 2030."

(UN-Habitat 2012a, p. 60)

Demographic boom in Algier causing traffic problems

The city of Algier had 3.3 million inhabitants in 2010 and is built on a long and vivid history (Helders 2012). The last century has seen the city grow to house the largest population in its history in a demographic and spatial boom. One of the main drivers was an immigration of refugees during the civil war of 1991–2002 (Kagermeier and Niedzballa 2005). During the last three decades, the city changed planning paradigms often, which has resulted in various partly completed settlement patterns (Ibid.). In 2004, a survey of 1,202 inhabitants of the city Bab Ezzouar (5 km from Algier) showed that only 8.7% of all trips were due to internal traffic, while 80% of all trips were contained by the broader metropolitan region (Ibid.). This shows an insufficient provision of low centrality services (Ibid.). As a result, average trip lengths of commuters and inhabitants requesting services and goods of higher centrality are very long, congesting the insufficient transport infrastructure on a daily basis. Although two thirds of all motorized trips are still made by bus and rail, the public bus company is not able to keep pace with growing demand, enabling a growing reliance on private motorization (UN-Habitat 2012a).

In recent decades, OPEC countries have spent a major share of their income on reshaping and erecting the putative cities of tomorrow. In these city projects, the planned transport systems rely to a great extent on private motorization. Most of the municipalities in the MENA region were unable to realign transport planning policies to accommodate the fast changing urban development challenges resulting from the region's massive population growth.

As a result, growing travel distances in expanding urban agglomerations are mostly tackled with a fast growing stock of private vehicles and a privately-operated, only partly regulated, and insufficient public transport which consists largely of mini-vans and shared taxis. From an environmental and social perspective, this unsustainable development of the urban transport system, particularly the public transport system, has fostered excessive reliance on private automobiles (The World Bank 2010a).

The unplanned or inadequate urban transport environment and the low level of supervision has increased the negative internal and external effects of transport, such as:

- an inefficient distribution of transport origins and destinations, leading to long travel distances,
- major accessibility deficits especially in the sector of public transport (social exclusion) and non-motorized networks (bicycle lanes, pedestrian lanes),
- high maintenance costs of street networks,
- congestion and rising travel times (e.g. in Cairo, the average road speed will drop from 2008's 19 km/h to 11.6 km/h by 2022),
- energy-inefficient transportation means (mass transit systems are missing),
- rising GHG emissions as well as high levels of both air and noise pollution,
- growing numbers of traffic fatalities,

(UN-Habitat 2012a; UNDP, GEF 2008; The World Bank 2010a, own additions).

While a shift towards more environmentally-friendly orientated urban transport planning policies is beginning to happen, the impacts of the uncontrolled urban development of the last decades will be a key-challenge for municipal planning departments. The current reliance on private vehicles combined with an ill-suited urban environment will remain the major challenges for the successful implementation of high capacity public transport systems. Nevertheless, there is a discernible shift away from large, construction-oriented, and expensive projects towards more integrated, stronger organization-related policies.

Egypt's energy consumption

In 2009, most of Egypt's energy consumption was met by oil (47%) and gas (48%). The U.S. Energy Information Administration (EIA) estimates Egypt's 2011 oil consumption at about 815,000 barrels per day, an over 30% increase since 1990. This increase is driven by a rise in industrial output, growth of the economy and the population, as well as increasing vehicle sales. The consumption of electricity also increased over the last decade by 7% a year, from 61 billion kWh in 2000 to 116 kWh in 2009. It is estimated that electric generation reached 137 billion kWh in 2010. Almost 90% of electricity is generated from oil and gas processing methods. Egypt has proven oil reserves of 4,4 billion barrels with a daily production of 710,000 barrels. This output decreased significantly over the last decade, but new technologies allow for extraction from smaller fields and enhanced oil recovery (EOR) techniques further ease the decline output. The slowly decreasing domestic production makes meeting the rapidly increasing demand a major challenge (EIA 2012).

"In recent years, population, urbanization and industrial growth have resulted in rapidly increasing demand for electricity across MENA. Over the next decade, total electric demand in the region is expected to grow by 7 percent annually with more than 120 GW of new generation capacity needed by 2017. In Saudi Arabia alone, various analyses have indicated a possible shortfall of as much as 60 GW between peak electricity demand and existing and planned capacity by 2032, if domestic consumption patterns persist and the country continues to rely so heavily on hydrocarbons."

(Sultan Al Jaber 2012)

Fig. 26: Cooling with a split compressor device (Huber)

The residential and industrial sectors both mismanage energy consumption. Oil and gas production is very energy intensive. Most energy is wasted through gas flaring or venting, both very inefficient and environmentally unfriendly ways to use fossil resources. Highly energy intensive industries are also showing rapid growth. Processes such as desalinization of water, aluminum smelting, cement, glass, and production of other construction materials which consume significant amounts of both electricity and time. These processes are not modulated in their output and end up blocking use of the power grid for other consumers (Luciani 2012).

The residential sector as well as the industrial sector are major consumer of energy. For example ,in Algeria, Kuwait, and five other countries, the residential sector's share of total consumed energy exceeds 50%. This is double the percentage consumed by Germany's residential sector in 2011 (Luciani 2012). Introducing energy efficiency concepts into the area's energy consumption will be crucial in satisfying future needs. Much energy is also lost in transmission through the power grid. Israel is an exception, loosing just 2.8% of its energy in the grid, whereas all other MENA countries loose from 10.7% in Saudi Arabia to a maximum of 26% in Yemen. Therefore, improvement of transmission efficiency is an important goal.

Continuing population growth, increasing GDP, and rising purchasing capacities are leading to a growth in energy capacity of 7.8% per year (APICORP 2012 and CIA 2004). Governments now struggle to supply the demand for electricity in the fast expanding urban and industrial sectors. Between 2013 and 2017 the costs of improvements are estimated to be as much as USD 148 billion for procurement, construction, and engineering capital requirements (APICORP 2012).

5 Water Scarcity and Quality

"Water management problems are already apparent in the [MENA] region. [...] And the challenge appears likely to escalate. As the region's population continues to grow, per capita water availability is set to fall by 50 percent by 2050, and, if climate change affects weather and precipitation patterns as predicted, the MENA region may see more frequent and severe droughts and floods."

(The World Bank 2007, xiii)

Water Distribution Challenges in Saudi Arabia
In Saudi Arabia, 1,660 cities, towns, villages, and hamlets have water distribution networks, while 4,060 villages and hamlets rely on water tankers (MEP, UNDP and UNDESA 2010). In Jeddah, only a quarter of households have a direct water connection, although the water distribution network reaches 90% of the city. Households in low-income and informal settlements are especially reliant on tankers to deliver water, with costs as much as 150% that of piped water (Jeddah Municipality 2009).

Fig. 27: Old Mercedes-Benz-water-truck in Jordan (High Contrast 2009)

The MENA countries are part of the most water scarce region in the world, a situation which will be further exacerbated by climate change (cp. I 11). The IPCC predicts that the MENA region's temperature rise will be higher than the global average temperature rise. The Arab Water Council (AWC) is assuming a drop in rainfall of up to 25% by 2060 (Al Rahahleh and Kirsch 2011). Not only will this have additional negative impacts on available water resources, but this will be compounded as demand for water in cities is expected to increase due to rising temperatures, more frequent extreme heat events, and population growth, (Ruth and Gasper 2008). Furthermore, growing populations are also creating an increasing demand for food, which even further increases water demand for agricultural production. Although 85% of the region's water is used for agriculture, most of the countries in the MENA import more than 50% of their caloric intake (UN-Habitat 2012a).

Due to increasing water demand, countries have to withdraw water from their aquifers, leading to additional water stress. Furthermore, water quality is deteriorating and water supply and irrigation services are often rationed—with consequences for human health, agricultural productivity, and the environment. Disputes over water lead to tension within communities, and unreliable water services are prompting people to migrate, often from rural to urban areas, in search of better opportunities (The World Bank 2007).

Different Progress in Wastewater Management
In Yemen, only about 40% of the residents of Sana'a are connected to the sewer network and the remainder relies on on-site cesspits and septic tanks. Inadequate wastewater treatment has resulted in the pollution of the Sana'a Basin, the city's primary water source (UN-Habitat 2012a). But there are some positive trends. In 2009, Syria's Housing Ministry announced a plan to build 180 new sewage treatment plants nationwide (Global Water Intelligence 2009, p. 16). In Egypt the treatment rate of domestic wastewater is 80%, of which 100% is reused to irrigate landscaped areas, fodder crops, and even edible crops (UN-Habitat 2012a).

"The Ministry of Water and Electricity [of Saudi Arabia] estimates that the country will need to invest USD 20 billion in sewer networks and USD 17 billion in wastewater treatment facilities over the next 20 years"

(UK Trade and Investment (2010) cited in UN-Habitat 2012, p. 155).


Fig. 28, 29: Wastewater treatment in open infiltration pits
(28: Huber, 29: Grunwald)

Wastewater treatment varies widely in the region. While in some countries (e.g. Egypt) most of the domestic wastewater is treated, in other countries this rate is below 5%. Often, wastewater treatment plants have inadequate capacities or are entirely missing (UN-Habitat 2012a). Sometimes, wastewater is collected, but is not treated (cp. IV 3), and e.g. led into open wastewater lakes. This is especially a problem for informal settlement structures which often have almost no connection to the sewer network. Consequently, both the environment and inhabitants suffer from the negative impacts of surface discharge or untreated infiltration.

The extent of treated wastewater reuse varies significantly, and in some countries there is significant potential for improvement. Indeed, in a few countries, noteworthy political initiatives and investment programs are already underway.

7 Urban Air Pollution

"Pollution-related health problems, particularly in urban and industrial centers, are another challenge. The causes include open municipal waste dumps; the use of leaded gasoline in an aging and poorly maintained vehicle fleet; the inefficient use of fossil fuels for power generation; and particulate and sulfur-oxide emissions from industry. Hazardous waste and Persistent Organic Pollutants (POPs), such as those from obsolete pesticides, continue to pose a challenge in the region."

(The World Bank 2008b)

Huge Potential to Repress Urban Air Pollution
Syrian domestic heaters are about 33% the overall diesel consumption, while public transport vehicles consume 38%. Algeria is one of twelve countries remaining worldwide that still uses leaded gasoline; Libya and Mauretania are far above the 20 micrograms of PM10 per cubic meter standard set by the WHO (UN-Habitat 2012a).

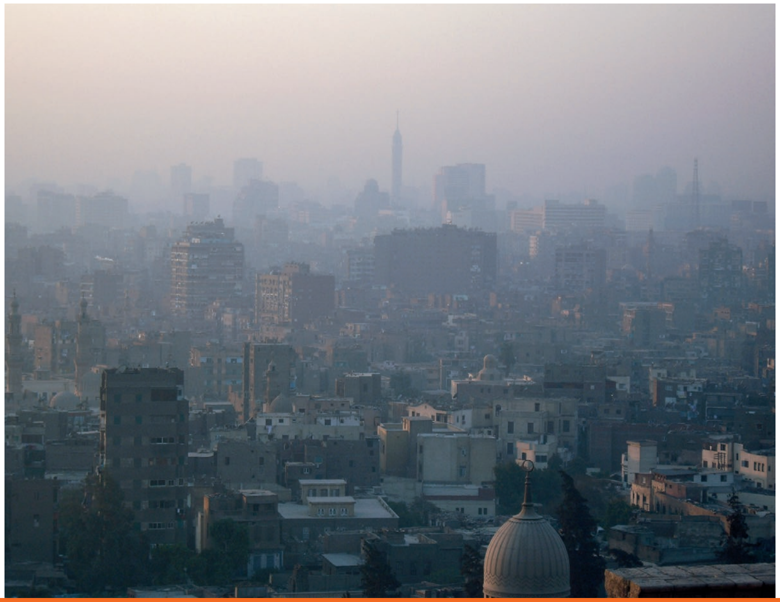


Fig. 30: Air pollution in Cairo (WANACU, TU Berlin)

Due to the arid climate and irregular rains, many MENA cities must deal with airborne dust. But, human activities are another main driver deteriorating city air quality, including growing motorization, use of aging vehicles, and industries, as well as heaters and other diesel machines. Key emitting sectors of sulfur dioxide and particulate matter (PM10) are transport and the industrial sector, which releases high amounts of these pollutants. Even though PM10 emissions per capita is decreasing, population growth is leading to an overall increase in air pollution. Great effort will be required if an acceptable and healthy air quality in cities and urban agglomerations is to be reached.

Threatening of the Mediterranean Sea
According to the University of Gothenburg (n. d.) the Mediterranean Sea is threatened by large-scale industrial activity on its coasts. More than 200 petrochemical and energy systems, chemical industries, and chlorine plants line its shores. Egypt is seen by far as the largest polluter of the Mediterranean Sea. Another permanent problem in certain areas is eutrophication caused by agro-chemicals and non-treated industrial and urban wastewater discharge.

"Coastal zones continue to deteriorate. Concentration of populations along coastal zones from migration and urbanization coupled with unregulated development adds to sources of untreated pollution and damage the scarce natural habitats that remain."

(The World Bank 2008b)

Fig. 31: Polluted beach on the red sea in Sharm el-Naga, Port Safaga, Egypt 2010 (Wikimedia Commons)

The four major marine systems in the MENA region are the Mediterranean Sea, the Caspian Sea, the Red Sea Gulf of Aden, and the ROPME (Gulf) regions. The marine and coastal environments are threatened by pollution, overfishing, loss of biodiversity, climate change, and other problems (University of Gothenburg n. d.). Many economic centers in the MENA, including major cities with high population density, and transportation hubs are located in coastal areas. They are drivers of pollution and degradation, but are also threatened by climate change effects such as sea level rise or saltwater intrusion into rivers and estuaries.

9 Waste Management

“An integrated waste management system geared to conserving resources needs solutions that are tailored to each individual country. There is currently no formal, structured exchange of experience on this in the MENA region. Various public and private sector actors are searching—often independently of one another—for technical, financial and organizational solutions. Endeavors to set up a sustainable and integrated waste management system are making slow progress.“

(GIZ n. d.)

Approaches for Enhancements in Waste Management
However, there are already signs that the challenge has been recognized and some approaches are beginning to tackle the problems. For instance, Algeria, Morocco, and Tunisia have developed national strategies for improving waste management. These include improved waste collection, constructing additional sanitary landfills, and rehabilitating open dumps. The UAE is implementing different initiatives to reduce waste generation (e.g. a phasing out of plastic shopping bags by 2012, the launch of a construction and demolition waste recycling plant in Abu Dhabi, and the development of a waste-to-energy incineration plant in Dubai) (UN-Habitat 2012a).

Fig. 32: Rooftop of a garbage collector in the Mokattam-District, Cairo 2012 (Deter)

As MENA region population and living standards increased in the recent years, so too did the amount of waste. In many cities solid waste collection systems do not function sufficiently and, as a result, garbage litters the streets and public spaces, detracting from their appearance. Collected waste is mostly dumped in open landfills, rather than in sanitary ones. Countries with small amounts of available dump space, such as Bahrain and Kuwait, have already run into capacity problems. Moreover, a market for reuse is missing, making composting and recycling unprofitable (UN-Habitat 2012a).

Governmental housing projects—Learning from Turkey
The past "Arab Spring" events, which have influenced political changes in many countries of the MENA region, are providing new opportunities to introduce transparent and reliable policies and institutions (O'Sullivan, Rey and Galvez Mendezi, 2012, p. 1). New governmental strategies are needed, for example, to meet the high demand for affordable housing. A move away from the traditional role of governments as "direct builders" towards public-private partnerships could be a promising approach (Maysa Sabah Shocair 2012). The Turkish government has set an example that could be relevant for many countries in the MENA region to deliver the mass housing projects urgently needed. With the goal of establishing public-private partnerships (PPP) the so called "TOKI" (Housing Development Administration of Turkey) was introduced. "TOKI issue tenders for the disposal of government-owned land for mass housing projects. Private developers are then invited to submit plans indicating how many dwellings they propose to provide and what proportion of these they are willing to give back to TOKI for the government to rent or sell to those in need of private housing. TOKI has delivered more than 500,000 housing units in over 2,000 projects over Turkey in the past 25 years" (Jones Lang LaSalle 2011).

"To implement plans successfully and manage increasingly large and complex urban systems, governments in Arab countries will need to better coordinate the complementary roles of central and local governments better and increase the participation of the private sector in urban development."

(UN-Habitat 2012a, p. x)

Fig. 33: Representatives of different stakeholders at a corner stone ceremony in Hashtgerd New Town, Iran (Young Cities Project)

Cities in the MENA region face a wide range of challenges. In many countries the rapid urbanization has led to a housing shortage, housing insecurity, and the growth of informal settlements. Moreover, infrastructures are often poorly equipped and overstretched. These immense challenges already are and will be further exacerbated by the effects of climate change. Both developments—the rapid urban growth and the mid to long term effects of climate change—require city management that efficiently provides jobs, social infrastructure, housing, and basic needs while simultaneously moving towards sustainable urban management. This requires an improvement of the overall regulatory environment for urban and housing development combined with an efficient city management - prerequisites often is not found in the MENA region. However, it is a highly difficult task to analyze the governance structures and challenges in the region. First, the political systems of the countries differ, varying from the elective monarchy of the UAE to democratic systems like Tunisia's to military regimes such as in Syria. These different government forms influence regional and city systems of governance. If there is one combining element, it is that a number of countries (such as Iran, Egypt, Syria, Saudi-Arabia and the UAE) have governance systems which are high centralized, with most local governments dependent on central government transfers to finance their activities and services (UN-Habitat 2012a). In these countries, it is often the national interior, road, or construction ministry that is responsible for the planning and implementation of development projects. However, in a number of countries—especially in North Africa—reforms have been initiated in order to decentralize their systems. Yet, central governments often retain their authority through control of the financial resources. In these cases, municipalities are frequently unable to finance urban projects and must rely on ministries or specialized national agencies (Ibid.). This fiscal centralization constrains local governments. Decentralization and multilevel governance are highly important for the progress of sustainable development in MENA region cities.

III
Vision, Principles, and Key Aspects of Urban Design for Resource-Efficient and Climate-Sensitive Cities in the MENA Region

This chapter presents the vision and principles for developing resource-efficient and climate-sensitive urban design in the MENA region as set out in the context of the Young Cities research project. Urban Form, Urban Resources, Urban Technologies, and Urban Governance are introduced as key aspects of an integrative urban design process involving a variety of planning disciplines. The key aspects are set in four different colors—colors which are also used for the highlighting of the key aspects' content in Chapters IV and VI.

1 Vision and Principles for Developing Resource-Efficient and Climate-Sensitive Cities

Sebastian Seelig | Holger Ohlenburg

In recent decades, there has been a global shift among urban design academics and practitioners towards a focus on sustainable cities. Indeed, 'sustainable cities' and 'sustainable urbanism' are well-established terms, widely discussed since the 1990s. By balancing environmental protection, economic growth, and social development, this concept gains its significance through a broad and holistic approach which recognizes the complex interactions of societies, ecosystems, and economies.

The rise of climate change as a worldwide scientific and political priority has lead to new visions for sustainability in the urban context, such as the CO_2 neutral city, the low carbon city or the "Eco City" (Lehmann 2010). These models, based on reducing carbon dioxide emissions, create sustainable environments by following the fundamental principles of resource efficiency and climate sensitivity.

The "Young Cities" research project shows how resource-efficient and climate-sensitive cities can be effectively planned, designed, and implemented using an integrated planning process and a holistic urban design approach which carefully considers the natural, human, and financial resources which are available locally.

Sustainable urban development is a vision-driven enterprise. Although complete realization of original concepts is not always possible visions and goals are necessary in order to inspire and engage different stakeholders in the development process. In this chapter, we would like to communicate our vision for a resource-efficient and climate-sensitive urban form which responds to the current challenges and opportunities of the MENA region, as outlined in Chapter I and II.

Resource efficiency

Resource efficiency means the consideration and preservation of all natural resources (incl. energy resources) via three main approaches :

1. *Reducing* the use of resources is the most promising approach of the three: it tackles the fundamental need to consume less, whether of energy, water or soil. Examples from the energy sector are minimizing the energy demand of a building through efficient construction and design measures but also through the entire life cycle, e.g. through the choice of appropriate materials. This strategy can also be applied in other sectors. For example, in transport, the energy demand for mobility can be reduced by physically bringing the origin and destination of trips closer together or the use of more energy efficient modes of transport and increasing public transport.
2. *Re-using* already existing materials can reduce the energy demand for the creation and transportation of the materials (Metcalf 2011). Examples are the reuse of buildings materials like bricks or paving material.
3. *Recycling* of materials mainly relates to wasted material as a resource from which new materials are produced, which reduce the demand for new raw materials and resources and can reduce emissions from transportation and production processes. Another excellent possibility to reduce emissions is to recycle wastewater and graywater. Treatment and recycling of graywater can significantly reduce the need for energy and fresh water without reducing the quality of life for the users.

Climate sensitivity

Climate sensitivity means to develop solutions which respond both to the local climate as well as to the global climate. The design of urban structures should respond to the specific local climate, to create cities with healthy living conditions, as well as consider global climate change, by reducing energy demand for heating, cooling, and transport.

While there are multiple ways to support these objectives in the built environment, a primary method is the configuration of the built and non-built environment. The urban geometry can influence the shading, solar access, and ventilation which define the microclimate of open spaces and thermal conditions within buildings. If effectively shaped, urban geometry can lower the surrounding temperatures in summer and allow for more sun in winter, reducing the demand for both cooling and heating. Technical measures such as shading fabrics and awnings can significantly support indoor and outdoor thermal comfort, especially in water scarce regions. Green structures, i.e. landscaping and planting, are additional tools for supporting climate sensitivity – green structures have cooling effects, provide shading in summer, and act as a carbon dioxide sink.

1.1 Planning and Designing in an Integrated Way

"The whole is greater than the sum of its parts" (UN-Habitat 2012a, p. 25). Integrated planning is the key to delivering resource-efficient and climate-sensitive design. Integrated planning is needed in order to create a city that safeguards a high quality of life, is economically healthy and competitive, all while protecting the environment (UN-Habitat 2012a).

> ***"The city is an interconnected whole. It cannot be viewed as merely a series of elements, although each element is important in its own right. When we consider a constituent part we cannot ignore its relation to the rest."***
>
> (Landry 2006, p. 5)

By combining and interrelating policies, measures, or designs, integrative strategies can create synergies in the urban context. In the planning process, it means that all relevant action fields and stakeholders are recognized, that conflicts and synergies are identified, and interests are balanced. Balancing public and private interests is a key requirement of integrated planning. Public and private interests ought to be incorporated via stakeholder and public participation procedures wherein they are weighed against each other and given fair consideration within the planning process. The duty on municipalities and their planning authorities is to ensure that the interests are duly weighed, that all matters warranting consideration are covered, and that there is no failure to appreciate the importance of public and private interests.

Integration is used in reference to three areas: (1) sectoral fields, (2) spatial scales, and (3) institutional settings.

1. The integration of different sectoral policies and measures in one coherent scheme is a major element of integrative planning. Instead of developing sectoral solutions in each field (e.g. housing, transport and energy, etc.) integrated planning aims at combining sectoral policies in order to create synergies. This thinking can be applied to a range of planning scales, all the way down to design strategies. On the smaller neighborhood scale, for example, putting together water disposal and green infrastructure uses recycled graywater for the irrigation of green spaces, which also reduces fresh water demand. Functional synergies can also be created on a larger scale, for example, the integration of density and land-use patterns with transport can lead to fewer and shorter trips by car and a higher share of pedestrian traffic on the modal split.
2. Spatial integration is a necessary prerequisite to the success of such functional integration. This means that planners working on smaller spatial scales, such as the neighborhood level, must consider physical and functional interrelations with the entire district, the city, and the region. Moreover, spatial integration entails incorporating parts of neighborhood systems, such as buildings and small green spaces, into the spatial and functional context of the neighborhood.
3. Achieving these integrated approaches requires an integrated institutional setting, including horizontal integration of sectoral fields and policies, as well as vertical integration of different political bodies and institutions, combining top-down and bottom-up approaches.

1.2 Adapting Planning and Design to the Local Environmental Context, Culture and Lifestyle

Adapting to the local context is a basic requirement for sustainable settlements. This means not only the natural context, but also the local cultural values and the specific lifestyles of the potential users. Incorporating both elements is not common in urban development projects within the MENA:

> ***"Recent development uses imported western architecture styles and techniques which are ill suited to Arab climatic conditions. New urban centers, such as Abu Dhabi, Doha, and Dubai showcase modern high rises with glass façades. […] These towers feature inoperable windows and create a huge energy demand to power air conditioning systems."***
>
> (The World Bank 2012a, p. 187)

Adaption of planning and design schemes to the local climatic context is a primary component of this research project. Neglecting the climatic context is highly unsustainable; local climatic conditions are a "fundamental influence" (Lehmann 2010, p. 233) affecting the energy demand for heating and cooling. High latitude locations are not only colder in winter, they also have longer hours of darkness, requiring additional energy consumption for lighting and heating (UN-Habitat 2011a, p. 52). In the MENA region the climatic context plays a decisive role: the region has very distinct climate zones ranging from arid, to semi-arid, to humid and cold. Topography also varies strongly, with climates at high altitudes differing from those in low lying areas. The following features of local climate which should be considered: temperature, solar radiation, precipitation, humidity, prevailing winds, and the sites' or cities' topography. When location-dependent solutions are applied, less energy is consumed, resulting in more sustainable cities, neighborhoods, and buildings.

However, other environmental aspects are also of major importance, including soil, flora, fauna, water, and the surrounding landscape. Incorporating the local landscape and environmental factors early within the urban planning process can lead to better adapted solutions and planning decisions, protecting valuable environmental structures, including ecosystem services, and functions. Environmental Assessment can play a significant role in this relationship.

Resource-efficient and climate-sensitive cities also need to be livable spaces which react to local history and cultural heritage. Unfortunately, in recent decades, this is often not the case for the region, as Tolba & Saab describe for Amman, Dubai, and Beirut:

> ***"Then there is the big change in commercial spaces vis-à-vis the traditional souks that has been brought about by the mall culture. In particular, malls tend to be isolated from the neighborhoods in which they are situated by large parking lots, and constituting mini-cities in and of themselves. Unlike the souks, such malls do not perform a social function within their areas."***
>
> (Tolba and Saab 2008, p. 42)

In our globalized world lifestyles are constantly in transition; modern and historical ways of living will always be in close relation with each other.

2 Key Aspects of Urban Design for Resource Efficiency and Climate Sensitivity

Sebastian Seelig | Holger Ohlenburg

> ***"Urban design is an integrative act. It depends on a broad understanding of environmental issues, possibilities, and consequences of developing different possible futures."***
> (Larice and McDonald 2007, p. 465)

Implementing resource efficiency and climate sensitivity requires integration of highly complex urban conditions. We see Urban Design as a *"collaborative and multi-disciplinary process of shaping the physical setting for life in cities, towns and villages"* (UDG 2012).

Fig. 34: Planning and research dimensions contributing to the integrated research, planning, and design process.

The making of cities does not only involve the design of buildings in a physical sense or planning of cities as a political and technical process, but "is about making connections between users and places, movement and urban form, nature and the built fabric" (Urbandesign.org 2012). For a holistic urban design approach to reflect the unique planning conditions of a city, a district or a neighborhood, it is crucial to analyze the local conditions, the climatic, environmental, social, cultural and political context.

A resource-efficient and climate-sensitive city can be achieved through consideration of the following four key aspects:

- **Urban Form,**
- **Urban Resources,**
- **Urban Technologies, and**
- **Urban Governance.**

2.1 Urban Form

> ***The physical form of the city is an "enabler" that can potentially influence the way we move around in the city, the way we heat and cool buildings, the way we supply cities with energy, and the way we create and use open and green spaces.***

A central aspect of creating resource-efficient and climate-sensitive cities is to define the urban form. In our case, urban form refers to the physical layout and design of the city, including its densities, land use, street layout, transport infrastructures, and building types (Dempsey et al. 2010, p. 22). Urban form does not refer to one specific scale—it describes the functional and spatial frameworks of an urban area on all scales. The relationship with resource efficiency and climate sensitivity is fourfold:

Movement

This first aspect is connected to the way we use the physical elements of the city, which is also defined by the opportunities the urban form gives the user. Certain spatial and functional configurations can enable a user to change his lifestyle and thereby reduce his carbon emissions. This essential interrelation is notable in regard to mobility. Within the city, urban form defines population and built densities, as well as land-use patterns and infrastructure systems, which then influence the distribution of goods and users. These patterns can influence the length of our routes and, thus, the way we move and which modes of transport we use. If densities, land use, and street layout create attractive proximities between different points of activity (such as homes, schools, or retail units) people may prefer to walk or cycle. If public transport is available the users

Masdar City

Fig. 35: Aerial view of proposed master plan of Masdar City (eastern orientation) (Masdar City)

Established in 2006 as a special economic zone in the emirate of Abu Dhabi, "Masdar city is a new kind of energy company that takes a holistic approach to renewable energy and clean technology" (Müller and Schön 2012, p. 287). Masdar is a wholly owned subsidiary of the Abu Dhabi government-owned Mubadala Development Company, a catalyst for the economic diversification of the Emirate (Masdar City 2011), and seeks to become one of the most sustainable communities on the planet. In order to achieve its sustainability goals, urban form plays an important role; planners acknowledged that the biggest environmental gains come from the most passive, and least expensive, tools: the orientation of the buildings and city, along with the city's form. Therefore, designers first concentrated on orienting the city grid and buildings in order to reduce the solar heat on buildings façades while increasing the cooling night-time breezes. (Masdar City 2011). Further, the mixed use of land integrates the activities while minimizing commuting times. The streets and squares invite people to enjoy the outdoors and the design of narrow and shaded streets encourage walking. Countless design characteristics provide the highest quality living environment with the smallest possible carbon footprint (Foster and partners 2007). Because of the convergence of these characteristics, Masdar city has received several awards, including the first World Clean Energy Award in 2007 and being voted the 2007 "Sustainable City of the Year" at Euromoney and Ernst & Young's Global Renewable Awards.

might use it in place of their private car. In this way, urban form can influence the travel behavior and consumption patterns of individuals, and thus indirectly influences energy consumption (as well as related GHG-emissions). Given that the MENA has the highest GHG transport emissions per unit of GDP, the general aim should be to develop neighborhoods that reduce the energy demand for mobility (The World Bank 2010b, p. 1).

Density and orientation

A second impact of urban form on energy consumption is at the scale of buildings and building groups, and is related to the geometry of cities: the building densities and types, their height, and their distance to adjacent buildings, all influence solar potential and shading, which greatly affects the heating and cooling demand of each building. If a building allows for solar radiation it may reduce the heating demand (especially in colder climates and in winter) whereas shaded objects may have a lower cooling demand (especially in hotter climates and in summer). The orientation of buildings to the sun, the shading of objects, and the building compactness all influence the building's heat gain and loss. These urban design strategies allow for significant energy use reductions at little or no extra cost by harnessing smart urban planning, design, and architectural measures.

Energy supply

The third aspect is how urban form relates to the way we supply cities with energy. Urban form has a direct impact on the energy supply systems as different urban structures allow, or do not allow, for different types of systems. Low density housing is not well-suited to supply by central systems with long pipes and comparatively few user connections, whereas higher densities are, allowing for a more efficient supply infrastructure. In a further example, urban areas with a more diversified land-use can be better adapted to concepts such as waste heat recovery, wherein heat released by commercial uses could be used in housing units.

Public open and green spaces

The fourth aspect is the relationship between urban form and the design of public open and green spaces. These spaces can fulfill a variety of functions in a resource-efficient and climate-sensitive urban environment, such as providing space for:

- technical or "green" shading structures (e.g. awnings or trees) as well as for structures with cooling effects (through evaporation and transpiration of water) to reduce urban heat island effects,
- cleaning and infiltration of storm- and graywater (e.g. by constructed wetlands),
- carbon binding in vegetation structures and soil,
- cleaning polluted air though vegetation structures, and
- fulfilling recreation functions for the city's inhabitants.

It is important to note that urban form is a central "enabler". It is even the change in user behavior which impacts CO_2 emission rates and resource consumption. Individual travel behavior and consumption patterns are crucial, and are borne of the sum of a great many factors, including the social status or income of the user, demographics, and more. The same holds true for the energy demand of buildings outside of the user's behavior, such as the technical building equipment and insulation levels. Yet, urban form is a major influencing factor over which urban governments have some control, and thus it serves as a key starting point for resource-efficient and climate-sensitive cities.

2.2 Urban Resources

High levels of consumption even provide opportunities for large efficiency improvements.

Urban design and planning goes far beyond defining just urban form, it also influences the way we use resources such as e.g. energy, water, soil, etc. This is especially important given that, cities and urban agglomerations (especially in developed countries) are major consumers of resources. These resources often originate far away from where they are consumed. Yet even locally provided ecosystem services and functions are often overused, and valuable environmental structures are significantly impacted or destroyed. This has been confirmed by recent research showing how urbanization goes hand in hand with increasing resource consumption. The UNDP states that, "countries with higher urbanization levels tend to have a significantly greater ecological footprint per capita, suggesting that cities may be 'bad' for the environment." (UNDP 2011, p. 457 ff.). Cities are places of concentrated resource consumption, due to the higher incomes of their inhabitants. Although cities only occupy 3% of the world's land surface, they produce 50% of global waste, account for 60 to 80% of global GHG emissions, and consume 75% of natural resources (UNEP 2012, p. 2). If policies for resource efficiency are not deployed now, climate change impacts can even exacerbate these effects in the future (e.g. increased cooling demand in cities due to rising temperatures and urban heat islands). However, these high levels of consumption provide opportunities for large efficiency improvements, which is the aim of resource-efficient and climate-sensitive urban design.

Furthermore, efficient use of resources decreases resource consumption, and thus pollution and impact on the global climate. Another positive aspect is financial savings where infrastructure services can be provided in a more cost effective manner and even expand services with little or no increase in cost (UNEP 2012, p. 2). This is especially important in the MENA, a region considerably shaped by water scarcity, an overuse of energy, a strong dependence on oil, and a lack of urban infrastructures (World Economic Forum 2010).

Best Practice > Urban Resources

Tunisia—Water Reuse for Peri-Urban Agriculture

The town of Soukra is located only 6 km away from Tunis, and like most other settlements in North Africa and the Middle East, local water resources and food production are being threatened by the rapid urban expansion. Consequently, farmers have become more vulnerable, where urban agriculture and farmer's interests have not been either protected or represented in municipal government.

In 2007, Club UNESCO/ALECSO, with funding from Canada's International Development Research Centre, started a project to mitigate the environmental threats farmers face, while providing them the tools to cope with poverty. With the help of local institutions, technicians built greenhouses with gutters that distribute rainwater into storage tanks, capturing enough to meet 60 percent of irrigation requirements. Following Tunisia's strict wastewater use regulation, graywater was also captured and used for irrigating flowers, and to irrigate olive trees. Thus, greater yields helped to create small businesses for the farmers who had largely been growing subsistence crops (IDRC 2007). This model of urban agriculture and its technical innovations are being spread across the region. The solutions pioneered in Soukra provide an excellent example of how to improve food security in a water stress scenario while simultaneously improving livelihood (IDRC 2007).

Best Practice > Urban Technology

Ain Beni Mather Concentrated Solar Plant

Fig. 36: Photovoltaic micro-plants (Morocco) (Isofon)

In 2009, Morocco initiated an important shift towards improving energy security while addressing climate change mitigation. With plentiful sunshine and physical attributes suitable for concentrated solar power, the Moroccan government, with the financial support of the World Bank, offset forth to install a massive concentrated solar power plant (Climate Policy Initiative 2012). Located in the East of Morocco the solar plant, called Ain Beni Mather, is an early pilot project currently supplying electricity to the Moroccan grid. The plant combined solar and thermal power, and is expected to produce 2000 MW of solar electricity by 2020. This helps augment Morocco's high reliance on energy imports, as well as creating a new source of income for the government, as the initiative calls for export of solar electricity to markets in Europe. By diversifying the energy supply and increasing energy security, the Ain Beni Mathar Concentrated Solar Power plant brings Morocco, along with the MENA region, into an important role in global climate change mitigation (The World Bank 2010c).

2.3 Urban Technologies

Looking at available and adequate technologies on the urban level includes a wide range of low and high technological solutions on different scales, from single building devices to large scale infrastructure.

Though urban design often is related to spatial, social, and functional measures or design solutions, solutions for resource-efficient and climate-sensitive urban structures must also entail technological components. In recent decades, global technological progress has created a wide range of sustainability technologies—be it urban hardware (e.g. renewable energy devices, smart grids, or intelligent building devices) or software (e.g. control software for buildings), resulting in a huge toolbox for architects, urban, landscape and infrastructure planners. However it is very important to note that technologies should not be understood in the narrow sense of "high-tech"—even low tech-solutions can efficiently fulfill the goals. This distinction between high- and low- tech makes clear that there is no single technological strategy or technology that can, "provide all of the [climate change] mitigation potential in any sector" (IPCC 2007, 58). Looking at available and adequate technologies on the urban level includes a wide range of low and high technological solutions on different scales, from single building devices to large scale infrastructure. Some examples for technological solutions in the built environment include (based on IPCC 2007, 60):

- *Energy*
  Renewable energy devices (hydropower, solar, wind, geothermal, and bioenergy), combined heat and power plants, concentrated solar thermal, and solar photovoltaic plants.
- *Transport*
  Public transport systems, fuel-efficient and clean vehicles, hybrid or electric vehicles, traffic management systems.
- *Buildings*
  Electrical appliances and efficient heating and cooling devices, insulation, meters.
- *Waste and wastewater*
  Wastewater treatment in central or decentral facilities such as treatment plants or constructed wetlands, energy from waste treatment.
- *Information and communication technology*
  Telecommunication systems, IT technologies managing city infrastructures.

As population and urbanization continue to grow, these technologies can play a major role in decoupling economic growth and the use of fossil energies in cities. However it is important to understand that technologies must always be adapted to the local context – the majority of these technologies are not yet mainstream technologies in a number of countries in the MENA region. For example, renewable heat and power and combined heat and power are still rarely applied. If technologies are implemented without respecting the local context it can lead to incorrect use and result in substantially higher energy consumption and costs than estimated in the planning phase. In some cases, it is necessary to re-engage with older technologies and approaches which have proved their efficiency over the centuries, as the vernacular houses and neighborhoods of the region impressively show.

2.4 Urban Governance

> ***Tapping the potentials of resource efficient and low carbon urban design needs systematic and integrated strategic planning.***

Urban governance can play a decisive role in creating or developing resource efficient and climate-sensitive urban structures by implementing strategies and measures that directly influence the built environment, natural resources, and infrastructures. For us, governance represents the process-driven dimension, which coordinates, curates, and steers urban developments, and in the MENA region, is often in the responsibility of city municipalities.

Unfortunately, addressing climate change and its drastic effects are not always at the top of (or even on) the agenda of city governments in the MENA region. Housing shortages, informal settlements, urban poverty, a lack of secure property rights, and current political uncertainties are more pressing concerns for these cities (Madbouly 2009, 11 ff.). However, in the face of increasing environmental problems and global climate change, with drastic regional and local effects, developing sustainable urban structures should be seen as an urgent matter. Independent of challenges such as poverty and housing shortages, planning solutions for tackling climate change and resource protection should be integrated into broader strategic policies and programs as "no-regret" measures, rather than as "stand-alone measures".

It is of major importance to fully incorporate climate-sensitive and resource-efficient principles into urban planning frameworks, rather than pursuing isolated policies for climate or environmental protection. Many aspects of resource efficiency and climate sensitivity are already steered by urban planning and can be achieved with the existing tools. Land-use (compact urban form, mixed uses), transportation (public transport and non-motorized means of transport), technical infrastructure planning (smart energy supply, water supply, and wastewater management) as well as the protection and provision of green spaces and green structures can

Best Practice > Urban Governance

The Strategic Plan Amman 2025

Fig. 37: A view of Amman, Jordan 2005 (Bjorgen)

Amman 2025 is a planning initiative that was set up in 2006, as the Greater Amman Municipality faced the challenge of tackling the rapid expansion of the region, the economic boom fueled by foreign investment, and the need to protect cultural heritage and social diversity. The Amman strategic plan illustrates the renunciation from traditional master planning in favor of a more strategic approach, which not only immediately tackles the city's problems but also raises planning awareness in the minds of citizens and enhances the capacity of the local government. However, the plan still entails elements of traditional master planning in its comprehensive nature, focusing on the physical form and specifically on land-use and transportation. The strategic character of the plan is represented by a strong stakeholder involvement and public participation, the combination of planning and rapid implementation, the form of documentation and communication, and capacity building of the involved stakeholders. Stakeholder involvement ("mayors round table") right from the start and community participation and public consultation in the later phases became cornerstones in the planning process. A second innovation was the merging of planning and implementation-plan preparation and implementation were addressed at the same time, so parts of the plan were already realized (e.g. Bus Rapid Transit System), when others were still under formulation. Along with this came the expansion of the capacities of the municipality, achieved by the creation of the Amman Institute, a nonprofit think tank headed by the mayor and responsible for drafting and implementing the plan (Beauregard and Marpillero-Colomina 2011). "In short, Amman 2025 was not just about planning; it was also about enhancing municipal government and making Amman more prominent in the lives of residents and more comprehensible to outsiders" (Ibid. 2010, p. 17).

be influenced by urban planning frameworks. Combining these fields requires integrated and strategic planning approaches and processes.

Continuity of implementation is also a decisive factor in the success of a certain measure. Many measures are not implemented continuously, especially when they are related to development projects.

Though it is very difficult to draw general conclusions concerning MENA's planning systems and practice, authors indicate that the existing planning approaches have been too static and inadequate. Some countries have central governments with a top-down approach and a tendency to focus on long term master plans, which do not react adequately to dynamic social, economic, and environmental changes (Benna 2002). Strategic urban planning can help overcome these hurdles, and can be defined by the following characteristics (UN-Habitat 2009, p. 60):

- Participatory,
- Visionary, and long-term oriented,
- Scenario-based,
- Implementation-oriented,
- Evidence-based (monitoring and evaluation).

Though strategic planning is seen as tool for the city level, we see strategic planning as a set of values that can be applied to any spatial scale, even the neighborhood unit. Breaking strategic planning down to a process reveals the following steps:

- Definition of aims,
- Analysis of local situation, including identification of stakeholders,
- Setting respective key performance indicators,
- Developing planning scenarios with defined decision criteria,
- Participation of stakeholders,
- Final definition of measures,
- Approval/decision,
- Implementation of measures,
- Monitoring of measures according to indicators (and potentially plan and realize further adaptation measures).

Strategic urban planning and strategic environmental assessment should complement one another to steer this process towards optimally considered solutions.

2.5 Cities and Neighborhoods as Key Areas for Change

> ***"A clear and realistic view of neighborhood form and function is a prerequisite for the planning of development so as to promote health, equity and sustainability. Central to such a view is the recognition that neighborhoods are not separate units but interconnected parts of the urban continuum."***
>
> (Barton, Grant and Guise 2010, p. 30)

The approaches and strategies presented above show that cities and neighborhoods are places of concentrated resource consumption which can be key locations for change. If future urbanization in the MENA region proceeds at predicted rates, resource and energy consumption and thus local, regional, and global environmental consequences will only increase further. Again, it is not only the physical space of the city which needs to change "but the activities that take place within urban areas and that are undertaken by people of different ages, genders and income groups" (UN-Habitat 2011a, p. 36). However, urban spaces can influence people's activities and behavior indirectly through urban form.

Besides this, cities not only offer huge potentials for change but are effective places to initiate change. City administrations have the capacity to mold outcomes in the crucial fields of urban form, infrastructures or greenery through programs, plans, and regulations, with the engagement of other local stakeholders. Another important asset of cities is their intellectual capacity. Cities benefit from the clustering of specialized people working in both academia and business, developing and implementing new technologies—OECD calculates "that 73 per cent of OECD patents in renewable energy come from urban regions" (UNDP 2011, p. 460).

Beyond the city level, neighborhoods, as smaller spatial units, are very efficient places for change. The spatial scale of neighborhoods is especially suitable for new and integrated approaches. Not only are efficiency gains more easily achievable (e.g. implementing district heating or public transport) but also the neighborhood-scale is especially advantageous for action in terms of speedy and local analysis, simulation, and implementation of the built environment, for energy and water supply systems as well as public transport measures.

Another advantage is that neighborhoods are "learning environments": they are spatial entities, where different actors come together and need to coordinate action. This leads to better learning effects than in isolated environments—an energy consultation of a whole house is more efficient than of a single flat and the learning effects for the individuals are higher since the coordination efforts are larger (BBSR 2012b, p. 7). In addition, social interventions are more easily transferred as they are less cost intensive than technological innovations.

A final benefit lies in the inertia of the city and the neighborhood: what is once realized cannot be changed easily. So every intervention has long-term effects—this requires careful strategies in the built environment. That innovations can be tested on a relatively small scale, and if successful, can be upscaled is one more advantage with potential multiplier effects.

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IV

Parameters of Resource-Efficient and Climate-Sensitive Urban Design for the MENA Region

This chapter delves into a deeper description of the parameters and key aspects crucial for the successful implementation of the visions and principles elaborated in Chapter III. Each planning discipline involved in the Young Cities research project contributes a subchapter elaborating approaches and solutions for various scales (e.g. architecture, urban planning) and sectors (e.g. energy, water, transport, and landscape planning) and their impacts on the key aspects introduced in Chapter III. Additional sub-chapters are presented for Environmental Assessment, citizen participation, and assessing and monitoring neighborhood sustainability.

1 Planning Processes for Resource-Efficient and Climate-Sensitive Neighborhood Design

Philipp Wehage

Sustainable planning is a comparatively young form of planning and is not generally defined in international science and practice. Although the planning procedure is often regulated in national or regional codes, the specific project process requires contextualized measures and approaches in order to generate successful, regionally and locally adapted, sustainable planning results.

The urban and regional framework, as well as the plot and building scale, define the benchmarks for the planning and design processes. Programmatic and technological requirements need to be integrated within a complex, functional, and spatial unit of the urban quarter, the neighborhood, or the building. The complexity of planning steps should be reflected in an integrated process which incorporates the various requirements of the different scales and disciplines involved.

	Spatial Dimension	Technical Dimension	Socio-Economic Dimension
Region	·· Regional Setting ·· Topography	·· Waste ·· Mobility	·· Economics ·· Demography
City	·· Climate ·· Urban Form	·· Water ·· Energy	·· Employment ·· Market
Neighborhood	·· Buildings ·· Green Space	·· Information and Communications Technology	·· Education ...
Stakeholders & civil society			
Process Design			

Fig. 38: Exemplified aspects of scales and dimensions in the integrated planning process (Pahl-Weber 2012)

1.1 Participants and Stakeholders in Integrated Planning and Design

In general, the basic disciplines needed for integrated planning and design are: Regional and Urban Planning, Architecture, Landscape Planning, and Landscape Architecture. The main common task for these disciplines is the development of a balanced design for human habitat which incorporates the requirements of all stakeholders and planning disciplines.

Because there is no binding international code for the planning disciplines and their fields of action, a precise process definition, per task and context, is necessary. To begin with, the interfaces between disciplines can be defined in terms of scale (e.g. urban or building), planning measures (e.g. process governance and spatial design), and physical characteristics (e.g. open space and built up space). More detailed definitions are bounded by national or regional legal regulations, although professions like "urban planning" do not have official descriptions (Pahl-Weber 2010, p. 489).

Engineering and planning disciplines, including transportation, energy supply, water and waste management, as well as environmental assessment need to be integrated into one holistic approach for resource-efficient and climate-sensitive neighborhood planning (as formulated in Chapter III 2).

Two main groups of planning process stakeholders can be identified by analyzing influences on urban development:

- The stakeholders affected by the process result, e.g. target groups, investors, administration.
- The stakeholders who are process actors, e.g. the planning disciplines, investors, and responsible administration.

Some actors are based in both groups. For example, the local administration has, on the one hand, great interest in planning results in terms of local development while, on the other hand, it is responsible for legal regulations concerning the planning process (e.g. planning supervision, mostly installed in local/regional/national administration). Because of this, planning processes are characterized by integrative governance at both procedural (e.g. public consultation) and operational levels (e.g. integration of planning disciplines).

A strategic planning process should aim to generate visionary and long-term results. This definition calls for sustainable development of urban settlements which includes a specified degree of flexibility for local and future adaptation.

The central task for governance of any urban planning process is balancing customer and stakeholder goals at the programmatic level with the requirements of technological, economic, environmental, and social dimensions.

1.2 Integrated Planning Processes—Approaches

One central task, and benefit, of a successful integrated planning process is the consideration and balancing of interests. Early integration of all relevant stakeholders allows conflicts between programmatic and technological requirements to be more easily identified and helps avoid expensive corrections during the implementation phase. Moreover, synergies between disciplines can be identified, which increases resource efficiency.

Although there is no pre-defined optimal planning procedure, at neither regional nor international levels, international developments of recent decades show movement away from the ideal visionary "master-planning" to the process orientated "strategic planning" (UN-Habitat 2009, p. 47). The process is defined by a strategic approach with three planning phases (OBauB Bay 2010, p. 48):

- The first phase is the analysis and definition of goals, which forms the framework for further planning. Through a discussion based process, political, administrative, and citizen stakeholders come together with various experts to define and evaluate project goals in light of the local socio-geographical background.
- The second phase is the planning process of the disciplines as they define goals for scale-specific and legally binding planning products.
- The third phase is project implementation, followed by a monitoring phase which evaluates the project results including stakeholder satisfaction.

Although this phase-model suggests a linear process, feedback and adjustment loops between the phases are a beneficial and necessary part of the process and avoid top-down master-planning. This participative, balanced method characterizes the entire project—from goal-definition though to the final development.

The integrative approach is the core of successful sustainable planning. However, the planning method which characterizes modern planning approaches, in the MENA region and globally, is based on the perspective of a single planning discipline. Generally, in master-planning, the integration of sectoral planning results is arranged in a more or less independent, consecutive procedure. This means that the sectoral results must fit within a pre-defined urban vision and valuable synergies which emerge in a parallel working method are lost. Participation of all sectors from the beginning of the planning process is highly beneficial for a project. This allows stakeholders and disciplines the opportunity to weigh, and thus balance, the advantages and disadvantages of their goals, requirements, and measures.

Urban Form

- The strategic planning process is characterized by integrated planning results and continuity across scales. The determinations of planning products influence products and processes of other scales. By specifying spatial framework determinants, such as density, and classifying a certain land-use as the functional framework, the neighborhood design can begin to be formulated.

Urban Resources

- Sustainability is rarely considered in the existing regulations and codes of the MENA region, creating a challenge for further development of planning processes.

Urban Technology

- In integrative planning, all stakeholders and disciplines are involved from the very beginning. This allows for careful weighing of the advantages and disadvantages of each sectors goals, requirements, and measures, resulting in a better overall design.

Urban Governance

- In integrated planning, the procedural framework for neighborhood planning needs to be adapted to the specific technical, economic, environmental, and socio-cultural project context.
- The consideration and integration of sustainability in planning processes can be achieved at two levels: by defining programmatic tasks as result of case specific findings in a specific project context or by integrating process findings into legally binding planning tools (i. e. codes or guidelines).

Strategic planning is characterized by continuity across scales and integrated planning results. The determination of planning products influences the products and processes of other scales. Regional or city level land-use specifies the broader programmatic and spatial framework. By specifying spatial framework determinants, such as density, and classifying a certain land-use as the functional framework, the neighborhood design can begin to be formulated. Integrating sustainability aspects, such as green and open spaces, programmatic provisions (e.g. Mixed Use Zones), or technical and social infrastructure (e.g. energy systems), also influences land-use and spatial determinations.

> ***Density as a spatial determination for land has to balance resource sustainability and economic interests. In other words, the economic benefits of different densities should be discussed in connection with the long term benefits of a sustainable development.***

Density significantly influences energy efficiency in both social and technical aspects. The level of resource sensitivity (e.g. through passive energy impact) is also density-dependent and must be balanced with the other goals of this context.

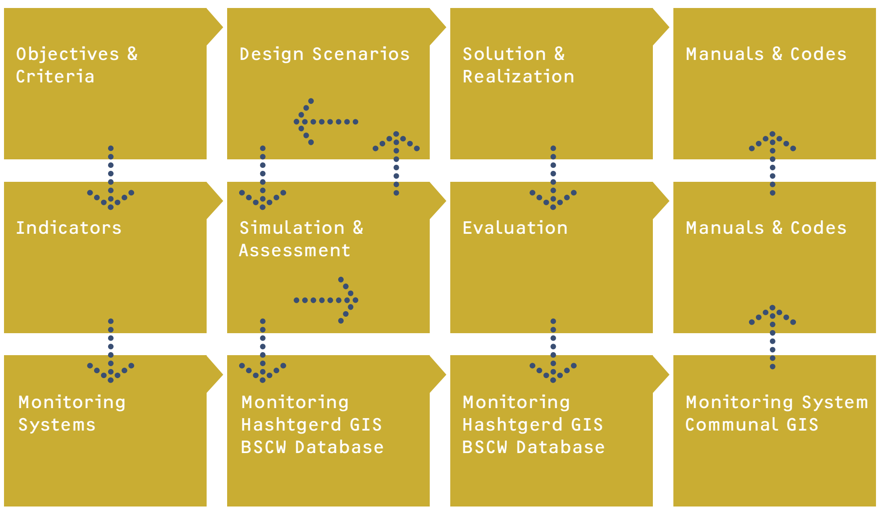


Fig. 39: Example of a methodological approach: "Design, Simulation and Documentation" from the Hashtgerd New Town pilot project (Pahl-Weber et al. 2010, p.61)

The revision and updating of planning results is crucial for strategic and integrative processes. The integration of the results of a participative milestone (e.g. public consultation) creates a revised planning product (e.g. Detailed Plan). The weighing and balancing of interests allows for a holistic and contextualized result.

1.3 Scenario and Revision

The procedural framework for neighborhood planning needs to be adapted to the specific project context and planning steps are in need for revision.

One suitable process that allows for this revisionary approach is scenario work. By considering several options (e.g. design scenarios), the various perspectives of disciplines and stakeholders are highlighted. By comparing different design scenarios (e.g. in plans and sketches), planning results and consequences are assessed and revised which helps to define the next steps. This method allows for swift adjustment and decision making.

Another example of revisionary processes is the participation of stakeholders via public consultation.

1.4 Resource Efficiency and Climate Sensitiveness in the MENA region—Goals and Results

The integration of sustainable and resource efficient aims in neighborhood design is highly influenced by the contextual definition of land-use at local and regional scales.

Most of the MENA countries have planning regulations and codes which rarely include sustainability, making incorporation of sustainability goals a challenge.

> ***The consideration and integration of sustainable aims in future planning processes can be achieved on two levels: the definition of programmatic tasks as result of case specific findings in a specific project context, or the integration of planning process findings into binding planning results (i.e. plans) as general legal requirement***

Existing regulations and codes can conflict with sustainable aims. For example, the “car free neighborhood” is an excellent form for low carbon urbanism, yet most MENA region national codes are still based on private vehicles with the infrastructures and access systems regulated accordingly. This creates challenges on two levels: first, exceptions from the existing law will need to be made; second, a fundamental task of the planning process will be to provide a real alternative to private vehicle mobility.

Planning codes should be checked for sustainability and the revisionary process can provide adaptations to present and future sustainability requirements.

2 Integrated Design Solutions for Resource-Efficient Urban Form in the MENA Region

Philipp Wehage

Resource-efficient and climate-sensitive neighborhoods, as a social, spatial and functional unit of urban form, arise from an integrated design process which considers all relevant components. An integrated process incorporates the complex interdependencies and relational aspects of all functional and design components and disciplines.

> ***The local and regional contexts, in combination with the population's socio-cultural background, are major influencing factors in the designing of urban form. Possible contradictions between the requirements of the different components and disciplines involved, need to be balanced in a site specific design solution.***

2.1 The Actors in Urban Form

Creating a resource-efficient urban form involves certain, specific planning approaches. In general, the integrative work of shaping the urban layout is based in the disciplines for spatial design, like urban planning, architecture, landscape planning and landscape architecture. The disciplines and stakeholders which must be integrated are based on two levels:

- Programmatic level and
- Technical execution level.

The programmatic level is characterized by the requirements and goals of stakeholders. These emerge from the economic, social, and environmental goals and need of a project. Stakeholders in urban development projects include: political and administrative authorities, investors, present and future users, and any other relevant representative.

The technical and executional aspects of all the disciplines involved in planning have a direct impact on the final urban layout. The main disciplines are outlined in Chapter III 2.1 and depend on the specific project. This chapter focuses on the aspects most relevant to creating sustainable and resource efficient urban form in the MENA region, including:

- land-use and density,
- building configuration and design,
- movement and access,
- open space design,
- energy supply.

2.2 Strategic Approach for Urban Form

Resource-efficient urban form is a spatial arrangement of urban agglomerations which capitalizes on synergetic benefits between various planning needs and disciplines. The local context and specific project conditions need to be analyzed project-by-project in order to accurately identify potential beneficial synergies. The formulation of a context-based approach for designing a resource-efficient and climate responsive urban form which maximizes possible synergies includes both the structure of the planning process and the planning vision.

2.3 Characteristics of Urban Form in the MENA region

2.3.1 Designing a Socio-Cultural Adapted Urban Form

A major characteristic of the MENA region is its socio-cultural background rooted in the religion and culture of Islam. The lifestyle associated with this common background influences and creates a framework for future development. Although local specifics deviate from the broader character, general assumptions and principles are still useful. Wirth (2002) gives general information about the culturally rooted tradition of urban form in the MENA Region.

> ***The origin of vernacular urban form and its elements are not exactly provable and the characteristics are not always transferable to contemporary and advanced designs. But the knowledge and reflection of main aspects help to find cultural adapted design solutions.***

One main characteristic of traditional urban design and architecture in the MENA region is a specific spatial and functional arrangement of the Middle Eastern city (Bianca 1991 and Wirth 2002). From ancient to modern times, a cultural definition of privacy within the spatial hierarchy—from city to quarter, neighborhood and house—greatly influences the region's urban form.

In traditional cities based on this spatial hierarchy, the urban form was fitted to the population, vehicles and energy sources of previous eras. The contemporary context of today's MENA region is defined by personal-vehicle based mobility and the consumption of fossil based energy. Contemporary neighborhood design in the region often tries to merge the culturally rooted sense of place with modern lifestyles, combining the formal organization scheme of traditional neighborhoods with the needs of current infrastructure systems.

The local administrative context is a further influencing factor in the urban form of neighborhoods. Guidelines regulate the urban form on several levels, but in part due to the high demand for and mass production of housing, resource efficiency is generally no the focus. New or revised measures and tools are needed for planning processes to develop strategies for sustainable settlements, as well as to help support the debate with the local authorities.

The challenge for future development of resource efficient urban form in the region is to reflect the cultural and spatial phenomenon of the neighborhood and city design while considering resource relevant aspects and contemporary needs. The design and dimensioning of public and private spaces in urban form is a crucial aspect of integrating technical and functional needs into the social and spatial unit of the neighborhood.

Urban Form

- The proportion of open space to built area should be designed to support the definition of public and private space.
- Dense urban form and a compact building configuration go together. Closed coverage reduces façade surface area and, thus, energy loss.
- Take full but careful advantage of the potential passive energy benefits of compact urban form while considering and balancing these advantages with potential thermal losses.

Urban Resources

- Reducing sealed soil through dense urban form improves the microclimate and creates open spaces. Climate adapted vegetation in green areas, in combination with shaded open spaces, reduces evaporation of water and increases infiltration.
- Reducing the built area offers the possibility to create open space with innovative systems to improve climate quality and enhance resource efficiency, such as gray water treatment.

Urban Technology

- A dense urban form facilitates efficient infrastructure systems. Compact and dense urban units allow for efficient and unit sized energy systems such as block heat and power plant (BHPP) or Earth Tube Collector.

Urban Governance

- Mixed-use schemes should be prioritized. Combining housing with facilities for the provision of everyday local commercial needs creates livable neighborhoods and reduces the need for vehicle mobility while providing ready-made economic and social infrastructure.
- The arrangement of plots should allow for a variety of shapes. Building lines should guarantee implementation of the spatial concept and requirements of public-private spaces of the urban form.

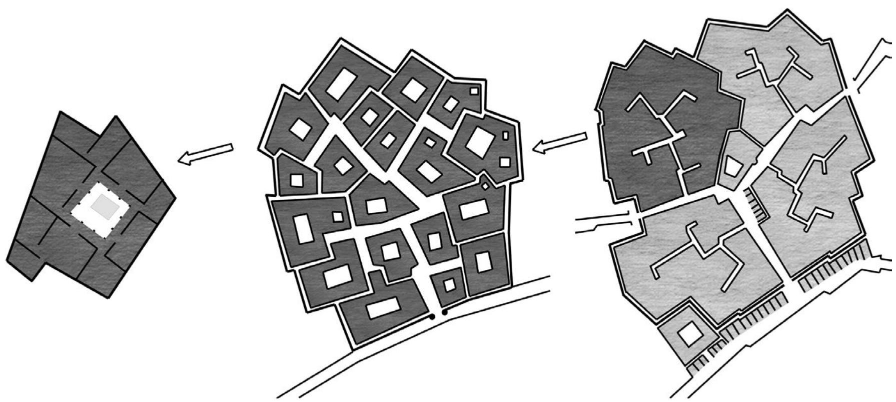


Fig. 40: Quarter, neighborhood, and house (based on Bianca 1991, p.151)

2.3.2 Designing a Site-Adapted Urban Form

Another major relevant aspect of resource efficiency is the geographical context. Topography and climate have direct influence on resource- and energy-efficient design for urban form.

Almost 70% of the MENA region is characterized by an arid climate, as stated in Chapter I 10, but the great extent of the region makes local analysis necessary. The urban form, the arrangement of built and open spaces, influences the micro-climate by determining sun and light exposure (e.g. solar incidence and shading) as well as affecting natural ventilation (e.g. wind and air exchange). Wind and sun incidence depend on the specific local climate and are influenced by the topography of the site. Topography, the naturally formed ground, both influences (speed and direction wind) and is influenced by (wind or water exposure) climate conditions. Similarly, wind, sunlight, and temperature all influence vegetation, while the vegetation influences the micro-climate. The ground, with its mineral materials and value for natural cycles, also has a high impact on local climate.

Supposing that every building on neighborhood scale creates an artificial topography, the impact on local climate is obvious. Likewise, the local geographical context can influence the resource efficiency of the urban form, e.g. through passive energy impact.

The urban form greatly influences the local climate and can allow for the use of renewable resources.

The high solar radiance in the arid and semi-arid climate of many locations in the MENA offers extensive passive energy potential. However, this impact needs to be consciously regulated to avoid overheating. A dense building configuration in a compact urban form allows for shaded spaces and surfaces to avoid overheating, reduces heat and cold loss by minimizing building surfaces, and creates a good micro-climate.

Through scenario work, the feasibility of transferring general principles of urban form can be checked in a specific site context.

For example, a generally efficient rectangular urban grid would be very difficult to plan and construct in extreme topography. Design scenarios can illustrate a project's scale and the site specific visions for urban form. By comparing several scenarios, one particular design solution can be formed from multiple ideas and serve as the basis for further detailed planning. The continuity of scale is a crucial characteristic of spatial design and should be the basis for scenario work. Determinations made on the urban scale establish requirements of other scales, for example at level of individual buildings. Moreover, specifying urban patterns requires coherent strategies in building design; for example, a dense and compact urban form does not fit with single detached building typologies.

Scenario work is a central tool for all design disciplines. It contextualizes general approaches to the specific conditions of the site and task. It does not stop on a specific scale or level, but rather starts anew after every milestone in the design process.

2.5 Resource-Efficient and Climate-Sensitive Urban Form

Within the local and regional context, several strategies can develop a site- and socio-cultural adapted urban form solution. With the integration of relevant planning disciplines at the technical execution level (according to

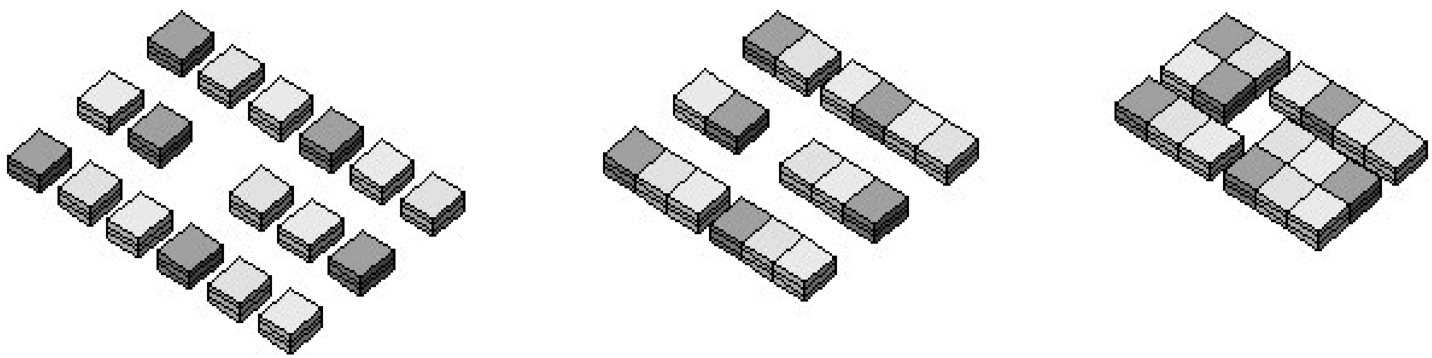


Fig. 41: Low rise and densification (Wehage 2012)

2.4 Methodology—the Scenario Work

The basis for designing a resource-efficient urban form is analysis of the local context. Analyzing the geographical and socio-cultural context allows planners to develop criteria for design scenarios. Creating scenarios is a suitable tool for showing different urban approaches and giving a visual impression of the project goals, as well as for comparing different strategies and their expected outcomes.

Chapter III 2.1), the main strategies for resource-efficient urban form are:

- minimization of thermal loss,
- maximization of passive energy impact,
- minimization of land consumption,
- optimization of mobility,
- optimization of infrastructure,
- optimization of synergies through land division and use.

Resource efficiency in urban form can be achieved through passive measures. Instead of enhancing efficiency through optimized technologies, the urban form offers the opportunity to generate efficiency through innovative and intelligent spatial arrangements. Optimized building and urban design can reduce energy consumption.

2.5.1 Minimization of Thermal Loss—Closed Coverage, High Density for Compact Urban Form

Optimizing building volumes can, among other things, stabilize a building's thermal behavior through compactness and surface to volume ratios. This reduces thermal loss through building surfaces and efficiently regulates the interior climate against extreme outside temperatures and seasonal or daily temperature peaks. Depending on surface- design and material, the influence of outside climate on interior spaces can be greatly reduced. This strategy must be developed in tandem with architectural design (see IV 3).

2.5.2 Maximizing Passive Energy Impact—Orientation of and Distances between Buildings

Maximizing passive energy impact means that urban form is adapted to use regenerative energy. The main regenerative energy sources are the sun, wind, and water. Passive energy impacts help to reduce the active energy demand for cooling and heating and, in turn, CO_2 emissions. Solar radiation is very intense in most MENA region climates. Many of the region's traditional urban form patterns were created in response to the intensive sun and wind exposure. Street layout was intended to combat high outdoor temperatures by channeling wind and providing shade. In regions with cold winters, sunlight on southerly oriented surfaces helped to reduce the need for heating.

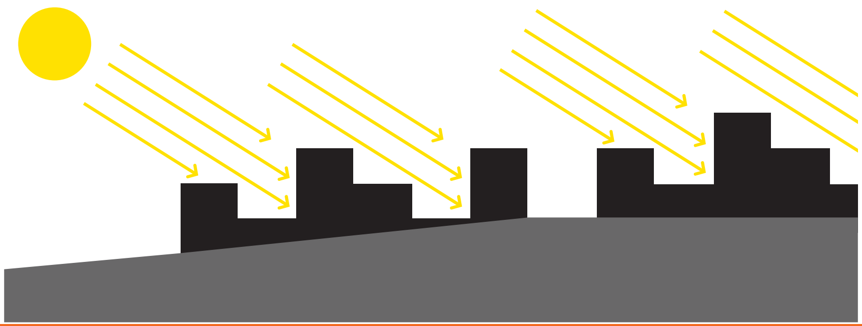


Fig. 42: Basic principle: passive solar impact (Wehage 2013)

The design of neighborhoods greatly influences the solar incidence and is directly related to architectural design of surfaces, openings and floor layout.

2.5.3 Minimization of Land Consumption—Densification of Built Area

Growing urban settlements are in need of land to construct new neighborhoods. To limit development's impact on natural resource cycles, the consumption of land should be reduced to a minimum. The compact and dense urban form of traditional MENA cities is a good approach for minimizing land consumption with a defined spatial system. Patterns with this low rise, high density scheme are economically and resource efficient. While the historic densification was motivated by the need for protection in conflicts or from climate events, today, the gained ground is an environmental asset, and could also, for example, be used for agriculture (a crucial resource for regions with little fertile ground).

Beyond the recreational potential of open spaces, the unsealed soil is also an important asset for natural resource cycles within modern urban settlements.

Because of water scarcity in arid MENA regions, the resource cycle value of unsealed soil is significant. Innovative concepts for active resource recycling can be installed in close relation to newly built areas. Some examples include: wastewater treatment, micro climate benefits of plant evaporation in green areas, or infiltration of rain water for closed water cycles,

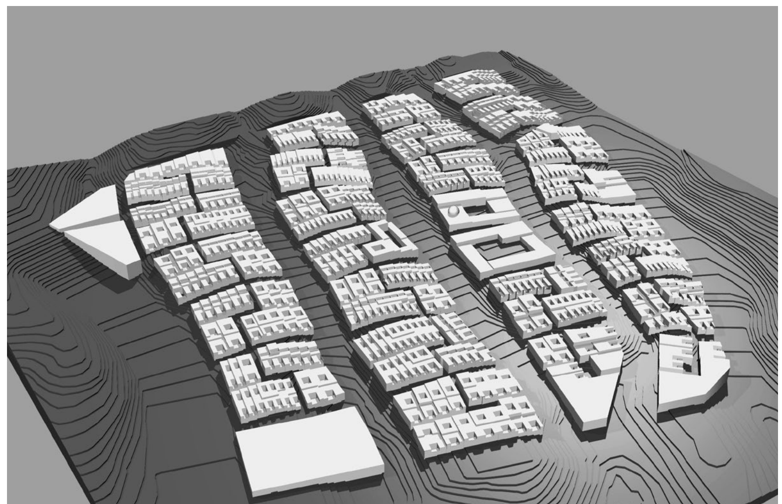


Fig. 43: 3D Simulation of Shahre Javan Community (Pahl-Weber, Seelig and Ohlenburg 2011, p.63)

2.5.4 Optimizing Mobility—Provision and Integration of Innovative Mobility Systems

Urban Form is in part determined by functional processes and, thus, mobility systems influence design. Each transportation mode requires a specific provision and dimensioning of space. Mobility in the MENA region is mostly composed of individual vehicles, one of the largest sources of CO_2 emissions. Sustainable alternatives to individual vehicles must be found.

An efficient public transport system needs to be developed and integrated within a city or region's concept in concert with efforts to minimize long distance travel in everyday lifestyles. This requires a good work-life balance based on a balanced land-use and mobility approach.

> ***The provision of places to work and for the supplying of everyday needs in close vicinity to neighborhoods, through mixed-use areas inside or nearby housing, can reduce the need for motorized travel.***

Advanced para-transit systems such as car sharing and e-mobility can also help to reduce emissions and minimize spatial demand for traffic.

2.5.5 Optimization of Infrastructure—Providing Feasible Systems and Integration into the Urban Form

Technical infrastructure is often related to supply systems. Defined urban units with high density, such as neighborhoods, can allow for semi- or de-central systems, such as block power plants.

> ***The intensive solar radiation of most MENA countries has great potential for energy production via solar heaters and photovoltaics.***

Solar exposed surfaces, such as roofs, offer extensive installation space for such systems. In terms of water and wastewater infrastructure, treated gray water can be reused, as mentioned before, for irrigation of local open green spaces. All these systems can directly link production and consumption in a close spatial relationship. Thus, the construction required for technical infrastructure can be reduced. The spatial provisions for these infrastructure innovations have to be integrated into the urban form at an early stage.

2.5.6 Optimization of Synergies through Land Division and Use—Balancing Requirements and Finding Synergies in the Spatial Design Process

Urban form integrates a variety of different and sometimes contradicting demands.

> ***The urban form is the spatial, functional unit of the design solution where balancing needs can offer opportunities for synergies.***

For example, relation between mobility and land-use described above (see IV 2.5.4) allows for site specific synergies concerning energy consumption. In dense urban configuration, the close distances between housing and work space or social infrastructure avoids long travel distances while supporting the liveliness of the neighborhood by increasing walkability and use of local streets and paths for social interactivity. Beyond the synergetic resource efficiency effects, a second major benefit is the balancing of the requirements of the spatial framework with the needs of inhabitants' lifestyles. This culturally and technically adapted urban space is crucial for the acceptance and success of sustainable planning.

3 Integrated Architectural Design Solutions for Resource-Efficient Buildings in the MENA Region

Philipp Wehage

The continuity of scales is a necessary part of an integrated design process as mentioned in Chapter IV 1 and IV 2. Every building is part of a larger urban arrangement and every urban unit is composed of smaller spatial units, thus spatial design scales are interlinked and interdependent.

Architecture, as traditional integrative design discipline, collects the individual needs of users and clients and balances them with the requirements of engineering a building.

In other words, a site specific building design solution is the result of balanced planning. This process is very complex; it must simultaneously consider numerous influences, impacts, and parameters. These factors are different in every project, and the holistic design approach of each sustainable, architectural project must be individually developed (McDonough and Braungart 2012).

Urban and architectural design are interlinked, and the definition of a site's urban concept determines the architectural framework. Characteristics and standards of land use, density, plot- and building design, and technical infrastructures are pre-determined by the urban design. Physical aspects of construction methods and materials influence functionality and have a significant sustainability impact. Intelligent choices for their provision must be made within the economic context of a project.

Beyond physical aspects and the availability of materials and technologies, the socio-cultural background also influences the external architectural appearance as well as the inner organization of the building.

3.1 The Actors of Architectural Design Processes

As mentioned in Chapter IV 2, the needs and requirements of both the programmatic as well as the final technical execution levels must be integrated at an early stage in order to create a sustainable spatial arrangement. For resource-efficient and sustainable building design in the MENA region, the architect's work intersects with the disciplines of urban design, urban planning, landscape design, civil engineering, and energy systems. The architect must know the work of all relevant experts, from the initial geological survey to the construction phase.

3.2 Strategic Approach for Architectural Design

Sustainable architecture has to be seen as contextualized design (McDonough and Braungart 2012). Thus, the architectural design adapts general aspects, such as type of use, to the specific project context. The site context is partially defined by the results of the urban design process. Geographical aspects such as topography and climate, urban form and plot layout, access and infrastructure all formulate the spatial and functional framework for architectural design. However, the programmatic framework, with its social and economic aspects, is borne of the socio-cultural background and of stakeholder participation. Together, these set the parameters within which sustainable and resource-efficient architecture must work, and become part of balancing the design process.

3.3 Characteristics of Building Design in the MENA Region

3.3.1 Socio Cultural Context—Designing a Culturally Adapted Housing Form

The continuity of scale as described in Chapter IV 1 and IV 2 regarding urban form has a similar significance for architecture too.

Building forms and types are decided by their functional purpose, such as housing or commercial use, and are defined by the culturally rooted habits and needs of the local population. The characteristic elements of such types can be identified by specific features in drawings of floor plans, sections, and elevations. The architectural scale of for the building design process generally ranges from 1:500 up to a detailing level of 1:1.

The spatial hierarchy deals with community and privacy, and is a central parameter for architectural design in the MENA region. The final step in this hierarchy is the absolute privacy of the individual home.

With all its local individualities, the archetype of the courtyard house represents a significant and suitable building type for housing in the compact urban form of most mid-eastern traditions. The type, generated as a climate- and socio-adapted housing form in vernacular architecture, combined Islamic culture's high demand for privacy with the demands on thermal envelopes in mostly arid and semi-arid climates (Wirth 2002). It represents the interaction of socio-cultural and geographical contexts.

> ***The adoption of international modern housing typologies in the 20th century organized the housing complex in an extroverted western tradition. The definition of space, as known in the introverted Islamic tradition, was turned inside out.***

This break in tradition allowed exposure to light and air by opening up the outer, public facing façades and led to the possibility of a multi story building. The former organizational-scheme of the neighborhood was turned vertical. The inhabitants had to reinvent the spatial organization or change their habits. The stairway was adapted as a vertical 'dead end' and defined as a semi-private space within Islamic tradition, yet the definition of privacy was broken by the opening up of the outer façades. An informal result of this spatial out-turn was the covering of windows with curtains. The private open spaces attached to the façades, such as gardens and loggias, are not frequented because of their public visibility and have, therefore, become peripheral use areas. They are often used as storage or

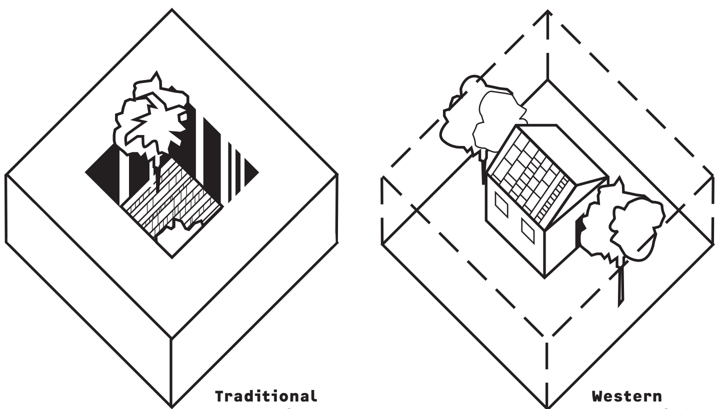


Fig. 44: The sense of place (Wehage et al. 2013, according to S. Manzoor)

technical supply zones (e.g. a space for air conditioners). In this sense, the relation of the façade to the outside creates residual-type open spaces in urban design of the MENA region.

The application of extroverted housing schemes in the MENA region often shows linear building arrangements, comparable to housing developments in the western world of the international modernist style. The broad, wide, linear urban space between the buildings, is a negative space

Urban Form

- Privacy is especially important in the MENA region. Introverted housing schemes, e.g. courtyard houses, offer climate and culturally adapted typologies in a dense, compact urban form.
- Coupled with dense urban form, the compactness of traditional courtyard housing reduces thermal envelope energy loss. Shaded courtyard micro-climates can deliver thermal comfort and air circulation through building morphology.

Urban Resources

- The technologies and materials of buildings should be chosen in relation to regional availability and quality. Simple constructions with vertical continuity of bearing elements reduce technological efforts.
- The thermal envelope is the most important element for the control of energy benefits and loss.

Urban Technology

- Because engineering requirements, such as construction methods and energy supply systems, significantly influence building design and construction costs, the related planning disciplines should be integrated early in the architectural design process. This integrated approach optimizes design in the planning phases and can reduce cost intensive changes in execution.

Urban Governance

- In most of the MENA region, the high solar incidence can create a surplus of heat, especially in summer. This must be considered in the planning of building volumes and southerly orientated surfaces. The façade design should provide shading devices to combat over-heating in summer.

which lacks quality due to its non-cultural adaptation.
The contradiction between privacy in a traditional Islamic understanding and the vertical housing typology in a western style is not yet sorted out (Wehage et al. 2013). Every housing design in the region should consider the local, cultural desire for privacy.

3.3.2 The Geographical Context—Design a Local Climate and Topography Adapted Housing Form, Respecting the Site Context

Regulations and parameters generated in the urban design process and given by local topography and climate form the spatial framework for every building design. Compact and dense urban form combined with the climate and topography of the MENA region, as mentioned in Chapter IV 2, is in need of suitable building types. Linear building arrangements, as a commonly used housing form in the MENA region from the 20th century through to today, exemplify a good approach for passive energy impact by maximizing the southern orientation of their façades. But contextualization conflicts with geographical and social aspects: both the need for privacy contradicts the need for opening up the façades and the high cooling demand for most of the MENA region in summer need to be considered in the architectural design.

In regard to topography, linear arrangements are well adaptable to plains. Mountainous topography needs differently adapted building typologies. Furthermore, the intensive land demand of linear building types conflicts with energy aims at the urban scale. Given the high costs of execution and the need to protect both the natural climate and resources, topographical interventions which prepare land for large linear building arrangements would be more effective if they first consider their economic and ecological effects.

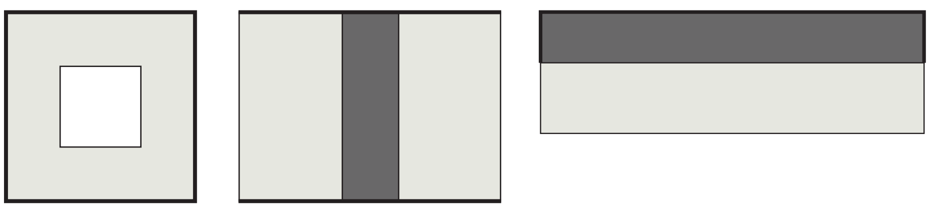


Fig. 45: Housing typologies and energy efficiency (Wehage et al. 2013)

As explained in Chapter IV 2, vernacular building types offer well adapted regional building typologies. The compactness of the traditional courtyard housing scheme is perfectly suited to dense and compact urban form. The shaded courtyards and their micro-climate deliver thermal comfort via air circulation catalyzed by the building morphology. But the sun impact and energy gain in winter periods is reduced to southerly oriented subzones. The introversion of this typology respects the demand for privacy. Of course, new designs for housing typologies should consider the historical, contemporary, and future social and technological contexts. New technologies and materials as well as changed habits in everyday life call for modern buildings. The vernacular elements and typologies need to be transferred to and transformed by compliance with today's societies.

3.4 Methodology—Typology and Scenario

The main aspects of architectural design processes lead to two methodological approaches:

- The Analytical Approach, characterized by a "top down" process, from a typological approach to a defined, specific solution.
- The Synthetic Approach, characterized by a "bottom up" process, from a specific context to a defined solution.

Design processes for sustainable architecture can come from both approaches.

> ***Design approaches dealing with general aspects (e.g. typology, use, and function) have to be contextualized (e.g. to urban and climate context) and vice versa.***

The Design process is an interactive development of solutions at different scales and levels, from overarching to detailed. The results of every step impact the definition of tasks for each subsequent step. There is no final recommendation for one design approach. No matter what defines the approach, a successful design process is a more or less simultaneous process of creative production and monitoring.

3.5 Resource-Efficient and Climate-Sensitive Buildings

Resource-efficient and climate sensitive architecture in the context of the MENA region contains aspects of volumetric and structural design as well as technological factors. This is the link to engineering disciplines. Volumetric design enhances passive energy impact and reduces thermal loss. Optimization of structural systems is a key factor in economic design. Technological optimization represents strategies for reducing energy consumption through application and use of innovative materials and systems. In other words:

> ***The level of resource efficiency is dependent on measures of static design as well as on the operation of technical systems. Both types of measures are integrated in the spatial functional unit of the building.***

Beyond this building scale, synergetic effects on urban scale allow for further enhancement. Passive design measures, such as shading or exposure to wind and sun, must be considered in the urban context. The successful application of innovative energy systems, such as decentralized energy supply, is dependent upon the urban framework.

3.5.1 Design Measures and Strategies for Resource-Efficient and Climate Sensitive Buildings

Building types can be characterized by specific attributes or elements, to facilitate identification of design measures.

Two main architectural elements represent approaches for resource-efficient and climate sensitive building design:

- The envelope, the physical shell between the interior (volume) and exterior of a building.
- The floor design, with the building access as the fixed anchor for the inner organization of the building volume.

The façade, as the thermal envelope of the building, defines the boundary between inside and outside. The structure of the façade is related to constructive and functional aspects as well as site-specific characteristics. Openings, which allow light and air incidence, guarantee the proper functioning of the building's volume-envelope relationship. The socio-cultural and physical dimensions of architecture, e.g. the graduation of privacy or the construction methods, are visible in the façade. Because the façade defines the interface of the private interior of the building to the public exterior of urban space, it also represents the interface between urban design and architecture.

The floor plan is related to the building type, and balances user needs with the site context of the building volume. A main characteristic of the building type is the method of access. Defining the routes of access, allows for identifying approaches to the floor plan and greater structure. This access system is a fixed dimension in architectural design. The floor design represents the user specific arrangement inside the building. It is defined by the method of entrance from outside, and it defines the accessibility of floors, dwellings and rooms within the building. The structural context, in construction and technical terms, combined with the access system and the building envelope paves the way to a graduated flexibility in floor organization.

For the building volume and arrangement, two main principles can be identified: maximization of passive energy impact and minimization of energy loss. For construction requirements, the choice of a contextualized structural design with suitable materials is a crucial factor for the planning of resource-efficient and climate sensitive buildings.

Maximization of passive energy impact

South oriented façades with numerous openings expose building volumes to the climate (Brunner et al. 2009). This measure allows for a high level of solar incidence and the associated passive energy impact. The floor design should be organized by this fact. Main living zones should be placed along the south façades to reduce the heating demand. This floor arrangement leads to more or less linear building volumes, which need to be considered in the urban configuration. On one hand, the density of buildings is limited by the distances necessary for solar incidence and by building height; on the other hand, the linear orientation must in accordance with the urban form.

In most areas of the MENA region, the high solar incidence can create a surplus of heat, especially in summer. This fact must be considered in the planning of building volumes and south orientated surfaces. The façade should be designed with shading devices to combat over-heating in summer.

Minimization of energy loss

In essence, the compact building form hides building volumes from the climate and thus helps avoid thermal loss (Brunner et al. 2009). The volume to surface ratio influences the compactness of building volumes. The thermal envelope (roofs, façades and ground-slaps) is the most important element for control of energy benefits and loss. Because of the high demand for quality in construction and detailing, the surface is a cost intensive building element. By optimizing the surface area through compactness, building costs can be reduced and a constant interior climate can be achieved for a deep volume. The floor organization must consider the high ratio of interior spaces with little natural lightning. One measure is to install an access and service zone in the inner zones of the volume (e.g. staircases and bathrooms) or, in deep volumes, to implement courtyards or niches for supplying inner zones with light and air. The supplementary surfaces, created by niches or courtyards decrease the compactness. In dry and hot climates, like in most areas of the MENA region, this measure could help to reduce the outside temperature of façades through shading.

Both strategies help to optimize resource efficiency in architectural design without any further technical- or infrastructural investments. A mix of these strategies should be used with caution, especially when

3.5.2 Design Measures and Strategies in the Planning Process

The base layer of measures and strategies for resource-efficient and climate sensitive buildings are largely architectural design measures based in planning disciplines for volumetric design.

The method by which design of the building volume influences the demand on energy is based in general physical principles.

confronted with possible contradictions (e.g. high ratio of façade surface for passive solar impact in relation to the optimization of volume to surface ration).

Construction systems and materials for resource efficiency
The technologies and materials of buildings should be chosen in relation to regional availability and quality. Simple constructions with a vertical continuity of bearing elements reduce technological efforts. The provision of traditional methods and materials can help to support local workmanship and companies as well as reduce efforts for fabrication and transport. The International Residential Code provides the basis for what is referred to as the conventional construction method, a method which generally allows for affordable building costs. The dimensions of housing, dwellings and room sizes should allow for the more efficient room widths. Flexibility in use is limited by these design specifications. Building height is another important factor. Especially in seismic hazard zones, construction efforts required for seismically safe high-rise buildings are remarkable. Because of the significant influence of building volume and floor arrangement, construction determinations should be integrated in the architectural design process at an early stage.

3.5.3 Design Measures and Strategies for Raising Efficiency Through the Application of Advanced Technologies

The next layer of measures and strategies for resource-efficient and climate sensitive buildings is based in the integration of efficient technologies in architectural design.

> ***Efficiency can be enhanced on neighborhood and building level through the application of advanced technologies. These measures need to be integrated into the energy supply systems of buildings and neighborhoods.***

Combining measures for both, neighborhood and building scales creates benefits for the community and the individual. Two suitable levels can be identified for integration of such measures in the building design: integration into the interior arrangement of building design and integration into the building design as an additional design layer.

Integration of systems in building design
One strategy for enhancing efficiency is integrating technologies through provision and arrangement of elements or spaces in the building design. One example is the heat recovery system. Advanced architectural design is in need of air conditioning; the vernacular architecture includes a regionally rooted system of air exchange which capitalizes on thermal principles. In combination with advanced technologies it is possible to significantly reduce a building's energy demand. A suitable system, which requires little technological effort is the heat exchanger. In combination with a pre-tempered air supply, e.g. through an earth tube collector at the neighborhood scale and building distribution via a constructed air-channel, the heat exchanger recovers the already tempered inside air and uses it for pre-tempering fresh outside air. The pre-tempering helps to reduce energy demand for cooling and heating.

Integration of additional design layer
The second strategy is the integration of technologies as additional layer of design. Shading devices help regulate solar impact on the building. Especially in hot summer regions, shading through curtains or covering of open spaces creates micro-climate benefits. An element from vernacular architecture is the covering of courtyards through mechanical or textile elements which reduces the direct solar impact and creates a comfortable semi-open space. In advanced technologies, these elements can be combined with the effect of light guidance (e.g. for naturally shaded spaces in winter) or the energy benefits of high-tech fibres (e.g. photovoltaic fabric). Because of the advanced technology and high quality standard of such elements and systems, the economic and technological standard of the region and specific project need to be considered first.

4 The Development and Establishment of Low Carbon Energy Systems as a Basic Step Towards a More Sustainable Energy Supply

Jörg Huber | Christoph Nytsch-Geusen | Tim Schünemann

Renewable energies have major advantages over the use of conventional fossil energy sources. With huge potential capacities of renewable energies, it is possible to provide clean and cheap energy for future generations.

The market for renewable energy technologies has developed significantly in the recent past and there are now a variety of technologies available for producing energy from renewable sources.

Renewable sources are defined as having an unlimited capacity, like sun and wind, or as resources which regenerate rapidly, like wood and biomass—compared to oil or gas which need millions of years to regenerate. The transition to renewable technologies and efficient energy consumption is the main goal of sustainable energy policy. Energy-efficient buildings, factories, and cars will reduce energy demand, making energy subsidies less necessary. Energy sources will become better utilized, making it possible to supply more household from the same capacities. Given this, it may be possible to reduce costs even as the energy sector grows—an important fact for a region where both wealth and living standards are rapidly increasing (Larsen et al. 2008).

Optimizing energy production, control, storage, and consumption in a huge network with many decentralized plants and consumers is made possible with the help of modern technologies. These technologies can be easily combined and expanded in a well-planned, modern grid. However, a well-planned, modern grid is only possible if more time and money is invested in the early stages of project development– two essential factors which are often not available.

Choosing the most suitable system is influenced by context-specific supply and demand, as well as by the combination of different technologies: systems which convert sunlight into energy (e.g. solar thermal and photovoltaic systems) are useful in regions which have superior solar radiation. Large parts of the MENA region are desert areas with high solar radiation and low population density, perfect for systems which convert sunlight into energy. The DESERTEC-foundation already draws some of its benefits from these facts (Desertec 2012).

Egypt has not only a huge amount of solar irradiation, but also a very high average annual temperature, which makes residential heating unnecessary. Therefore, solar thermal plants are only useful for hot water demand (for example with flat plate collectors). These plants are very small compared to other solar technologies. It is also possible to produce steam instead of hot water (with Concentrating Solar-thermal Power, CSP-plants) and generate electricity, a technology widely used in the MENA region (Ibid.).

The efficiency factor of these combined systems can be four times higher than that of normal photovoltaic systems (Raupach 2012). The disadvantage is that the more complex systems become, the greater the difficulties in handling and maintaining each subsystem (e.g. hot steam running through pipes, the right alignment of the mirrors, etc.) whereas a photovoltaic system is very easy to install and maintain.

In the following sections different innovative energy supply technologies are presented in more detail.

4.1 Photovoltaic Systems

Photovoltaic cells convert sunlight into electric energy. The global capacity of sun energy which reaches the surface of the earth is enormous with 1.5×10^{18} kWh energy received per year, or roughly 15,000 times higher than the yearly primary energy demand of the entire world.

The technology for solar cells has improved significantly over the past years and the development of a market in Europe, the USA, and China resulted in the continuous dropping of prices for solar modules, making solar more and more enticing for private households. The market includes a variety of different technologies, which vary mostly by materials used, their efficiency factor, and costs. Some technologies are mainly manufactured with silicon, which is made from sand, making them very cheap and widely available but with low efficiency factors of around 8%. Other technologies use rare materials making them more efficient but also more expensive and less sustainable (Wesselak 2012).

Photovoltaic systems can also be used as stand-alone-systems without connection to a grid, making them a viable option for taking over the tasks of diesel engines satisfying basic needs in rural areas like heating and lighting. This has several advantages, such as negating the need for polluting kerosene or difficult to dispose of batteries or of wood for cooking, allowing natural resources to be preserved.

Chapter VI 4 presents an energy supply system which uses energy generated by photovoltaics to operate a compression chiller to cool a building. If no energy for cooling is needed the overproduction can be fed into the wider electricity grid. Fig. 46 shows a pv-generator which produces direct current. The electricity is fed into an inverter and transformed into alternating current for the power grid.

4.2 Solar Thermal Systems

The basic concept of solar thermal systems is the transformation of sunlight into thermal energy. This technology is mainly used for heating. There are different technologies for thermal power plants, but all follow the basic concept of focusing radiation from the sun to capitalize on its thermal energy. The medium which carries the energy can vary from heated water to wax or steam. Similar to heating, it is also possible to use solar energy for cooling (hot water for cooling). The advantage to photovoltaic systems is that it is not necessary to transform primary energy into secondary energy and the thermal energy is more easily stored, simplifying the system and reducing costs. An absorption chiller is the technology which transforms heat into cold (Reichelt 2010). Given that cooling demand increases with solar radiation, solar energy is an appropriate, and likely abundant, energy source for cooling systems. Chapter VI 4 presents and explains a modified and improved cooling system for efficiently meeting Iran's cooling needs.

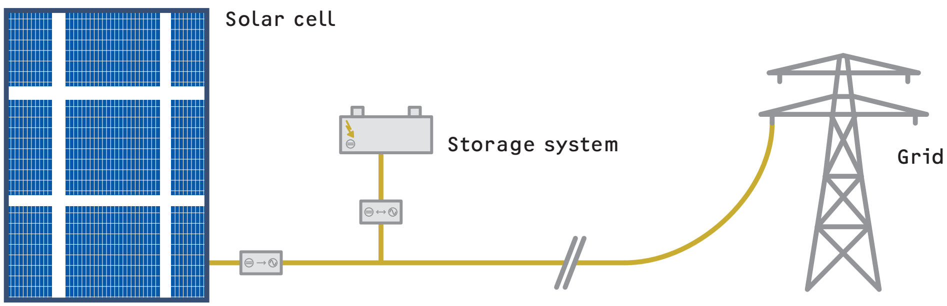


Fig. 46: Photovoltaic system

Figure 47 shows a solar thermal system for potable hot water and room heating. The collector field is connected to a heat exchanger and heats the combi-hot water storage where the water for heating purposes and potable hot water use is heated.

Urban Form

In integrated planning urban planners, energy supply, and traffic engineers work together and communicate from the very beginning of the project. This has a lot of positive effects on the new planned structure. The infrastructure for new technologies is planned by architects and engineers together which allows them to help each other, making the task less complex. In the end this leads to better outcomes and saves both time and money for the project.

Urban Resources

The technology change from fossil to non-fossil, renewable systems is expensive, but in the long term, costs for both the maintenance of the systems and the resources themselves will be less than the costs of conventional systems. The infrastructures for gas or oil pipelines are prone to failure and have only a moderate efficiency factor. Renewable technologies make much of fossil energy dispensable.

Urban Technology

The energy supply technologies with the largest potentials for urban areas in the MENA region are solar thermal or photovoltaic systems. These systems use very little space, are very user-friendly, and need little maintenance. There is a great deal of unused space on rooftops in most cities. This is an ideal place for a photovoltaic or solar thermal system. A centralized cooling or heating network makes sense only in urban areas or densely populated rural areas, otherwise the losses are too large and the efficiency too small.

Urban Governance

If only renewable energy is used for heating and cooling rather than fossil recourses, the smog will be reduced and air quality will improve. This would improve the overall urban health conditions and enhance the livability of urban areas (CCME 2012).

4.3 Wind Energy Plants

The MENA region also offers excellent conditions for wind power plants (MEED 2013). Wind technology does not yet play a major role in the region's energy supply as solar energy has been more interesting to MENA countries, because of the easier operability. However, this is beginning to change. Jordan, Yemen, Algeria, the United Arab Emirates, and Tunisia have recently begun to show more interest in wind technology. Morocco and Egypt have already installed a total of 830 MW, and announced that they would install a further 2.5 and 7.2 GW respectively by 2020 (WPM 2013).

One disadvantage of wind energy plants is the noise they emit, about 35 to 40 db which can be heard up to 500 meters away (Repo 2011). Further, wind energy plants can have negative impacts on lines of site, visually disrupting views inhabitants might value, and should therefore be a certain distance from settlements.

4.4 Combined Heat and Power Plants (CHP)

In conventional fossil fuel electricity generation, only 35% of the energy potential is used on average and the other 65% is lost as waste heat in re-cooling units. A combined heat and power plant (CHP) saves a great deal of fuel by utilizing this waste heat and can use up to 90% of the original energy potential. The heat is mostly used for heating buildings or industrial plants and can be distributed from the power station to the recipient via a local heating network. Unfortunately, heat loss increases with network distance, so a CHP is best used to supply nearby recipients. Today, 29% of the electricity in the Middle East is already generated by cogeneration plants and with plans to increase up to 40% by the 2030 (Siemens AG). Figure 48 illustrates schematically how a CHP heating and cooling system would work for an urban quarter. CHPs act as the energy generators and are combined with solar thermal collectors, several absorption chillers, and a distribution network to supply the whole quarter with heating and cooling for the buildings and their water.

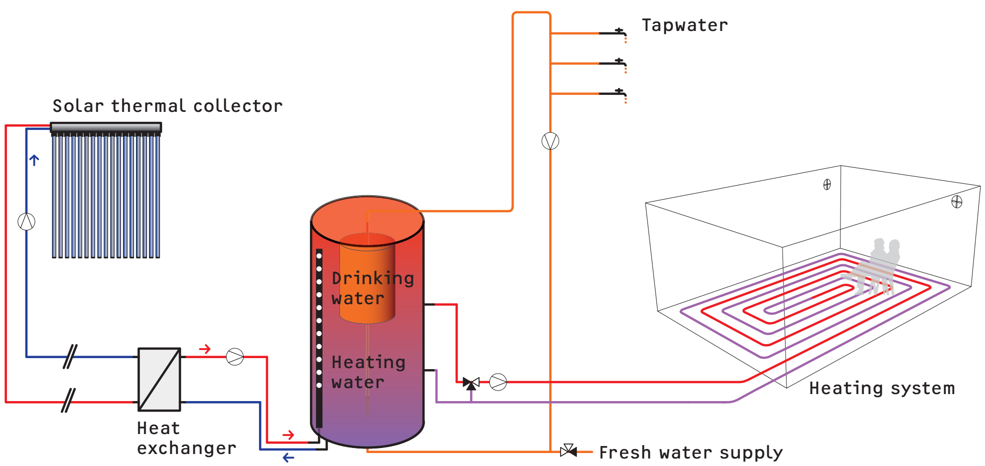


Fig. 47: Solar thermal system

Fig. 48: Energy system with a thermal energy network and centralized energy production

4.5 Conclusion

No specific innovative energy supply system can be said to be the best for the entire MENA region. The planning for each project and development will need to consider the regional and local conditions and infrastructure as well as the intended use and other project specifics.

The introduction of new technologies is only one possible option for bringing change to the MENA region's energy consumption patterns. Other options include the modernization of existing energy supply structures and motivating city inhabitants to use energy more carefully.

The availability of energy grids (natural gas and especially electricity) plays an huge role in any transformations of energy systems and consumption. Only with a nationwide grid can electricity be transported from the site of production to the consumer. This is crucial for the use of certain renewable energy plants, e.g. from the windy red sea to inland metropolitan areas.

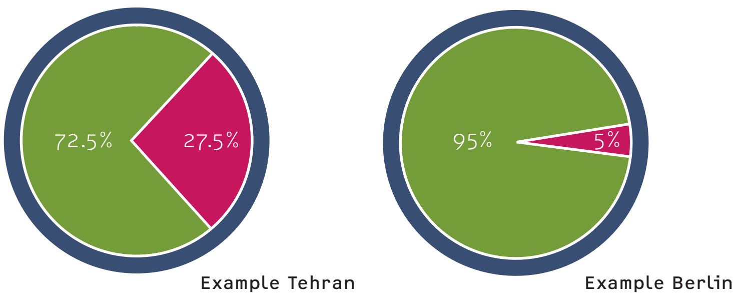
With smart planning, the household heating and cooling demand can be greatly reduced. For example the usage of shading elements such as trees or surrounding buildings can help with cooling. Correct orientation of buildings can allow photovoltaic systems to be efficiently integrated directly into walls and roofs (WEC 2013). An example of currently inadequate planning is the construction of thermal cladding: conventional design in the MENA region often has improperly sealed weld seams, which results in thermal bridges and gaps, leading to more heat loss and an increased U-Value (thermal transmittance through one square meter construction) for the building. Architecture forms the initial dimension which then allows the designers, developers, and engineers to build an energy-efficient future.

5 Water Management and Semi-Central Infrastructure for Efficient and Sustainable Urban Water Cycles

Tamara Nuñez von Voigt | Shahrooz Mohajeri | Martin Vocks

Water can be a limiting factor for urban development in the MENA region. In order to promote regional development, particular consideration should be taken for the protection of water resources and the reduction of water consumption. Therefore, a political paradigm shift is needed – away from supply-driven water management and towards sustainable demand-oriented strategies. Demand management refers to all measures for controlling the amount and quality of consumed water. There are two main, crucial issues which demand management must solve: promoting a prudent water usage of each consumer group and reducing water losses (see Fig. 49). The goal of consumption management is to reduce water consumption through modern sanitary technology and water-saving consumer behavior without a loss of comfort or hygiene.

> ***"In order to promote regional development, particular consideration should be made towards the protection of water resources and the reduction of water consumption".***
> (Mohajeri and Vocks 2011)



Demand management refers to all measures to control and override the amount and the quality of used water.

Consumption management refers to all measures for a rational water usage of consumer groups.

To reduce **losses** unaccounted-for water Management refers to all measures through e.g. illegal connections, measurement or human errors, leakages, own consumption, production and distribution losses etc.

Fig. 49: The two main issues of water demand management (inter 3 GmbH)

In order to achieve a prudent water usage of all consumers, modern water consumption management has to develop an interlinked network of measures for: technology, society, finance, and legislation (see Tab. 2).

Individual measures work best in concert and strengthen each other in appropriate combinations. All measures must be adapted to the specific water-use location (households, public installations, industry and agriculture) and their effectiveness varies within these. A separate catalogue of measures needs to be elaborated for each location and user group.

The consumption patterns of each location have to be understood in order to develop appropriate catalogue of measures. Once initial measurements are taken, the potential for savings can be estimated and evaluated for each location.

Technical	Social	Financial	Institutional/ Legal
·· Flow reduction through water saving devices ·· Increase efficiency ·· Use of recycled, treated wastewater instead of drinking water, where possible.	·· Information ·· Consulting ·· Education ·· PR-Campaigns	·· Water- and wastewater price management ·· Subsidies ·· Incentives ·· Extraction fees	·· Laws, regulations ·· Standards ·· Co-operations, agreements, allocation ·· Protection for drinking water areas

Tab. 2: Illustration of measures for water consumption management (inter 3 GmbH)

5.1 Basic Rules for Water and Wastewater Infrastructure Planning

When planning water infrastructure, there are several general planning principles which can help minimize resource consumption.

Modern wastewater systems are more sustainable when based in a decentralized or semi-centralized structure rather than a large centralized one; in fact, centralized treatment should be avoided. Less centralized systems provide several advantages:

- Investment in infrastructure only need to be made at the time when the system is needed, and not years in advance;
- Shorter networks are needed, significantly reducing investment and maintenances costs as well as energy consumed for the transport of water;
- A local water cycle can be easily created;
- Treatment facilities visible within the neighborhood will increase awareness and might thereby influence the habits of the local population.

A modular system design is preferable, especially if centralized structures cannot be avoided. Modular design enables stepwise construction according to actual need, avoiding unnecessary oversizing, which leads to higher energy consumption and reduced treatment efficiency.

Water consumption can be further minimized by careful substitution of fresh water with recycled, treated wastewater. Many water uses do not require fresh, drinking-quality water, such as irrigation, toilet flushing, washing of cars, or damping dusty streets. Depending on the intended use and provided wastewater a well dedicated treatment should be selected.

The separation of different wastewater streams must be given special consideration if wastewater is intended to be recycled. Different wastewater sources have different kinds and degrees of pollution. The gray water resulting from bath tubs, showers, and sinks has a very low degree of pollution but is the major part of typical household wastewater. The treatment of this wastewater is much easier than for the much more polluted wastewater from kitchen sinks and toilets. Toilet wastewater can be separated in two different sources: yellow water (urine), which carries many nutrients and is ideal for fertilizer production, and brown water (feces) which has a high organic load and can be used for biogas production. This separation of different wastewater sources is enables more efficient reuse of wastewater.

Stormwater also needs to be considered in water management planning. Rain can act as water source, especially for non-potable uses, and planning should consider its collection, storage, treatment, and distribution. If for some reason reuse of stormwater is not feasible, than it should at least be collected and distributed to enhance infiltration for groundwater recharge.

Wastewater streams can also be considered as an energy source:
- Anaerobic treatment of sludge or wastewater can be used for biogas production. This can be combined with the digestion of organic waste (co-fermentation) to further increase biogas production;
- City sewer lines can act as heat source or sink. By installing heat exchangers in the sewer, heating or cooling systems can be operated with significantly less energy demand than with conventional solutions.

Urban Form

- Decentralized water infrastructure systems have to be integrated in the urban planning process at a very early stage due to the need for dedicated space within each neighborhood.

Urban Resources

- The goal is to reduce water consumption without loss in comfort or hygiene.
- Reducing the amount of drinking water consumed and wastewater produced will also reduce energy demand.
- Water saving by using treated gray water, for irrigation or service water.
- Integrated concepts for water and energy infrastructure, like using wastewater heat recovery for warm water or producing energy from sludge digestion, are significant contributors to climate-sensitive urban design.

Urban Technology

- Water-saving sanitation technologies must suit local water consumption patterns.
- Semi-central and modular construction of wastewater infrastructures allows more flexibility in fast growing urban areas.
- Innovative adapted concepts for water and wastewater infrastructure should be developed using local materials and low tech solutions, like Constructed Wetlands, in combination with high tech components.

Urban Governance

- Politics needs to shift away from supply-driven water management towards sustainable, demand-oriented strategies.
- Develop and implement an adapted water consumption management concept which balances technical, legislative, financial, and social measures.

- Wastewater's hydraulic potential should always be taken into consideration: unnecessary pumping should be avoided and, in some cases, the potential is big enough to be useful for energy production.

Planning of water and wastewater systems should start early in an urban planning process. Especially for decentralized systems, which have to be integrated at a very early stage due to their need for dedicated space within each neighborhood. Water planning should also be closely attuned to energy planning. Important and beneficial synergies can be harnessed, e.g. warm water provision and energy out of wastewater.

5.2 Technologies for Resource-Sensitive Water Management

Beyond the conventional techniques for water provision, there are some valuable alternative water use and wastewater treatment technologies – a short overview of these is given below. These technologies include both high and low tech solutions. When selecting a technology both should be considered because low tech solutions often provide several advantages they are robust, easy to understand and maintain and entail low investment and maintenance costs.

High tech solutions on the other hand often have higher treatment efficiency and effluent quality, better controllability and more flexibility.

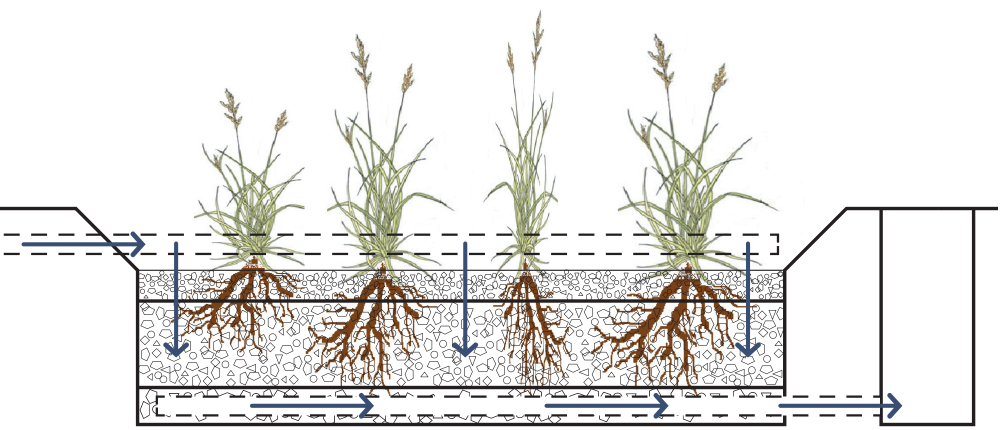


Fig. 50: Cross section of a vertical flow constructed wetland (p2m berlin GmbH)

5.2.1 Water Use

The installation of water-saving sanitation technology at the household level facilitates the economization of water use. It must not be forgotten, however, that even with water saving installations, the majority of consumption still depends on the user. Water-saving taps and consumption-reducing appliances cannot replace conscious efforts to use water sparingly. Most importantly, consumers should not fall into the "water-saving installation trap" and use new water-saving appliances more frequently than their old, standard appliances. Water-saving installations and appliances are intended to reduce consumption without bringing about a loss in hygiene or comfort. But comfort is subjective. Therefore, choosing appropriate technologies presupposes a detailed understanding of local consumption patterns, which are heavily dependent on cultural and climatic conditions.

Some examples for water-saving technologies are:
The minimum water volume required for toilet flushing depends on the type of toilet: while siphonic toilet pans require up to 14 liters, squatting toilets need only 3 l. But the actual amount of water depends on the flushing device and is often much higher than 15 l. These inefficient flushing devices should be replaced by water-saving flushing cisterns with stop button (0-9 l) or with a 2-button flushing system (3 l or 6 l). Water-saving showering not only prevents wasting valuable drinking-water but also spares the use of expensive energy needed for hot water. The amount of water consumed through showering depends on the volume of water dispersed by the shower head, the kind of shower valve, and their setting, as well as the individual showering time and frequency. The goal of water-saving installations is to limit the flow volume to a minimum while still maintaining comfort and not detracting from hygiene. Water-saving shower heads and flow-rate regulators installed in faucets use an aerator to lessen consumption by adding air to the water, which creates a normal, full water stream even the flow rate is lower (see VDI 2003).

5.2.2 Wastewater Treatment

Conventional wastewater treatment uses end of pipe technology with a centralized activated sludge plant. Depending on the circumstances, this can be the best solution. It can even be considered sustainable, especially if combined with reuse of the treated wastewater. However, centralized systems require long and often ill-forecasted planning periods which are not well suited to growing urban areas. Often, it is alternative systems and technologies which are a wiser solution for wastewater treatment. Some of the more important alternatives are presented here.

Constructed Wetlands (CW)

CWs represent a very robust low tech solution with good effluent quality. Wastewater is passed through a soil filter where microorganisms break down pollutants and nutrients. CWs are suitable for many types of wastewater, whether conventional municipal wastewater, gray water, black water, or stormwater.

CWs can be used as part very small decentralized systems, all the way up to relatively large semi-centralized or centralized systems.

Anaerobic Digestion
For sludge or more concentrated forms of wastewater (e.g. black or brown water), anaerobic digestion can be used to reduce the carbon content. This process produces methane, which can then be used for energy production.

While the technology is relatively simple a digester needs careful operation (e.g. a well defined temperature) in order to optimize the production of methane, or biogas.

Anaerobic digesters can be any size; however, a certain minimum size is necessary for the system to be economically feasible, making it more suitable for semi-centralized or centralized solutions.

Membrane Bioreactor (MBR)
In MBRs an activated sludge process is combined with an end of the treatment membrane filtration. MBRs can produce nearly any effluent quality required, suitable for every type of reuse except drinking. MBRs can treat any type of wastewater and are built in all sizes: from a very small plant for one household (equivalent to four people) up to large centralized plants. Compared to conventional plants MBRs are more compact and therefore need less space.

The disadvantages of MBRs are the relatively high energy demand and investment costs. As a high tech solution, MBRs have a high degree of mechanization which requires trained personnel for maintenance.

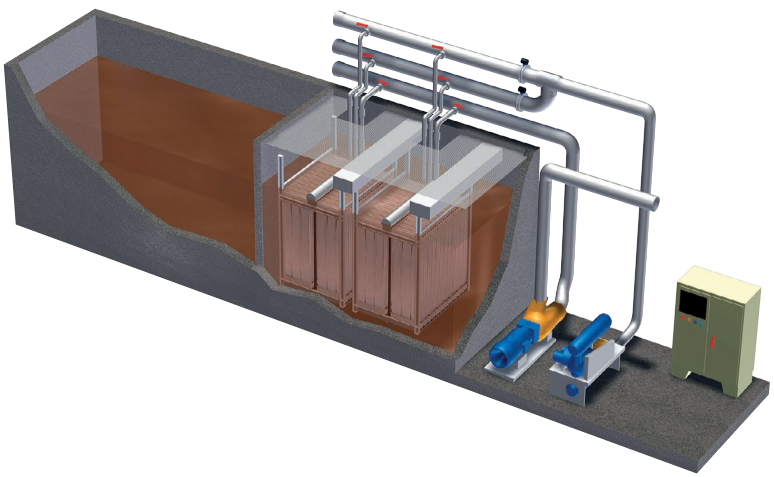


Fig. 51.: Membrane bioreactor (© General Electric Company; permissioned use)

Vacuum Sanitation
Vacuum sanitation can significantly reduce the amount of water required for flushing toilets. Vacuum systems need only 0.5 l to 1 l per flush (versus the conventional 3-15 l). Within this system, all toilets and sinks are connected to a single vacuum tank. Transport through pipes is not gravity-driven but rather pulled by the suction of the vacuum tank, greatly reducing the amount of water required for flushing.

5.2.3 Stormwater
Depending on climate conditions (e.g. the amount and pattern of precipitation), stormwater might be a source of water for some uses. If use of stormwater is feasible, it should be collected in cisterns and then treated to the needed quality. Possible treatments are sedimentation tanks, constructed wetlands, membrane filtration, or UV disinfection, depending on the target effluent quality.

However, if a direct use of stormwater is not feasible, the stormwater runoff from sealed surfaces should be addressed. It is better to allow the runoff infiltrate locally than to collect it and treat it in a centralized treatment plant. In this way, large stormwater sewers can be avoided and the stormwater recharges the local aquifer, which is a clear benefit for the local environment.

Depending on the origin (from roofs, low traffic roads, or high traffic roads) and, thus, the quality of the stormwater, it may need to be treated to a certain quality before it is allowed to infiltrate. More polluted stormwater (e.g. from high traffic roads) will need pretreatment, such as sedimentation, before the water is ready for infiltration. Less polluted stormwater (e.g. from roofs or low traffic roads) does not require pretreatment.

An excellent decentralized method for infiltration is a swale infiltration trench system. The system consists of a planted basin, which acts as both retention and treatment, and infiltration trenches underneath for the percolation. Swale infiltration trench systems require a certain amount of space and must be integrated in urban planning at an early stage. A less space consuming option is shaft infiltration, wherein an underground shaft with a permeable bottom and/or wall enables infiltration.

6 Innovative Urban Transportation Planning as a Prerequisite for Livable, Low Emission, and Low Energy Consuming Neighborhoods

Wulf-Holger Arndt | Norman Döge

The role of transportation in urban agglomerations is manifold. Transportation and commuting are a significant part of the average daily schedule and play an important role in the organization and supply of the urban environment. Historical transportation patterns are even the reason behind the existence of many urban agglomerations, especially in the MENA region, where many urban settlements are located at the crossings of old in-land trading routes or at the border between land and sea. If the city was not founded for military purposes, then their initial function was often that of a market center which provided the residents and surrounding population with goods that were locally not available.

From this perspective, transportation is the connection between place of origin and that of demand. In his Political Geography, Friedrich Ratzel described this central concept quite early:

> ***"Transportation is the spatial movement of persons and goods to ordained destinations with the intention of redeeming the world's and mankind's natural resources."***
> (Ratzel 1903, p. 447, translated).

In modern day, the functional spectrum of cities has been expanded, resulting in the emergence of additional land-uses. Yet, even today, the above statement is still valid, and these additional land-uses are the result of new needs for different goods and services. The following motives define the general transportation needs which influence daily urban and rural traffic (based on Schnabel and Lohse 1997):

- Living,
- Working,
- Educating,
- Procuring/Shopping,
- Recovering/Socializing,
- Transporting (economically motivated).

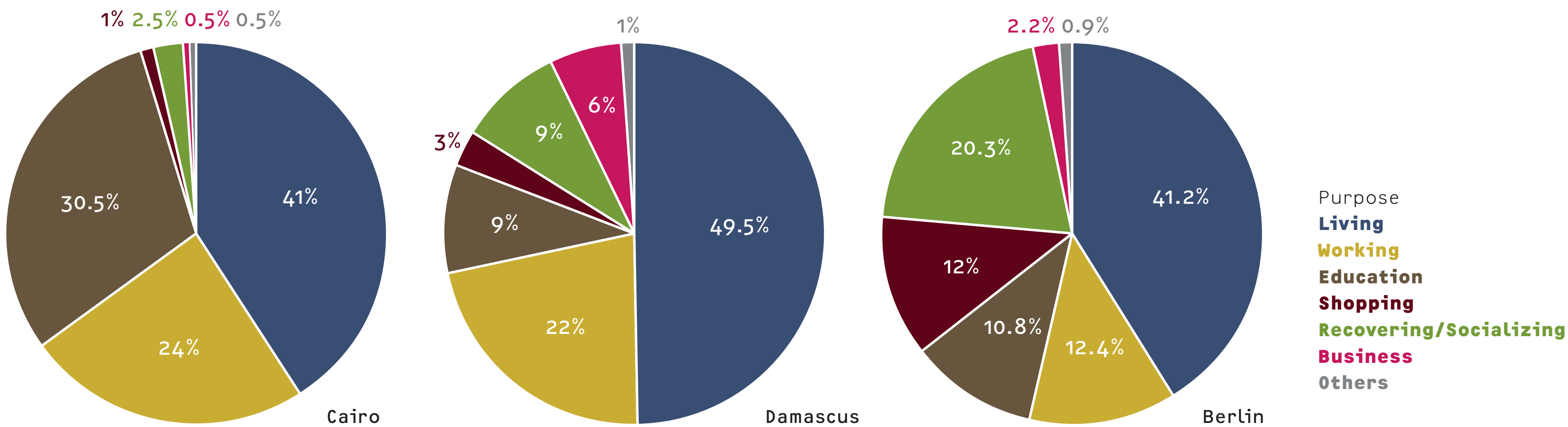


Fig. 52: Trips by purpose in Cairo, Damascus, and Berlin (based on Eastern Asian Society 2005, SrV 2008)

The following charts illustrate that the importance of each trip category is strongly influenced by the characteristics of the agglomeration. Thus, agglomerations with a comparatively young population, like Cairo, have a higher ratio of trips related to educational purposes. In Damascus and Berlin, on the other hand, educational trips are at a comparatively low level. The number of work-related trips in Damascus is as high as in Cairo, while in Berlin 20.3% of all trips are related to recreational or social motives. These examples show how statistics on trip purpose reflect a snapshot of that urban society's current state of development. Since characteristics vary from city to city and change over time, effective transport policies need to consider local and regional frameworks, anticipate future developments, and be revised as well as realigned to changing conditions at regular intervals.

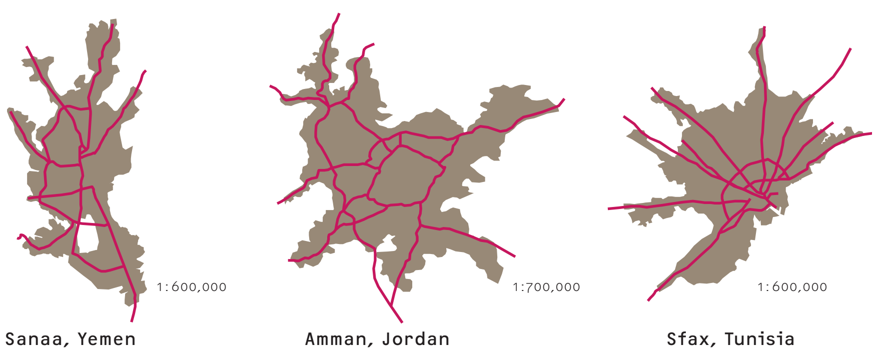
Although trip purpose and resulting demand are the main drivers for the number of average daily trips, their realization and average length are heavily dependant on the following factors:

- State of technological development,
- Urban and transportation planning paradigms,
- Government and municipal policies (subsidies, fares, organization),
- Available transport systems,
- Individual perception of different transport modes and related demand.

In this regard, innovations in transportation technologies greatly impact the development of a city and its planning paradigms as in cities of the western world ,changes in transportation technologies led to different transportation "eras," each of which significantly impacted urban form and organization.

Accessibility and travel cost are the two most decisive criteria in shaping agglomerations and their land-use structures. Especially in the MENA region, most city centers were built before or during the horse-car era, resulting in compact city shapes that are easily accessible by foot. The electric streetcar or transit era led to line based settlement extension. Today, this phenomenon is perceivable in cities where informal settlements are developed along the transport corridors served by informal line taxis and other forms of paratransit, as seen in the figure below.

As urban growth systems followed planning paradigms, the era of the electric streetcar was soon followed by the automobile era. The private vehicle greatly increased access for the individual and the car soon became the favored transportation mode, with planning policies realigned



Cartography: Adrian Horn, Norman Döge
Map base: Own Digitalization on Basis of Google Earth 2012

Fig. 53: Line based development in Sanaa, Amman and Sfax, 2012

Urban Form

The urban transport system is an integrated part of urban form, linking mobility and land-use. It has a significant influence on land-use configuration and the accessibility of functions that land-uses provide within the city context. Planning always needs to consider this central interrelation and integrate all planning fields.

Urban Resources

In many agglomerations, the urban transportation sector consumes up to a third of daily urban energy use. Although technological innovations may reduce emissions and energy consumption, the shift towards walking, cycling, and public transport has the greatest potential for reduction.

Urban Technology

Transportation technologies have a strong influence on the mobility patterns of citizens and location decisions of enterprises. The direct effect of technologies on the average spatial-time conditions of transport is an important long-term variable in land-use development.

Urban Governance

towards the needs of individual motorized transport. Density, as the decisive criterion for the economic viability of public transport systems, walkability, and livability, soon became of secondary importance.

Development of a transferable, integrated, and sustainable transport strategy for cities and neighborhoods of the MENA region must consider the diversity of urban and economic development within the region's countries. For example, cities like Tehran, Cairo, or Aleppo must deal with the consequences from decades of uncontrolled growth and development, cities of the OPC's were able to make large investments in planned urban extensions which prioritized private vehicles.

Controlled or uncontrolled, all countries share the growing negative effects, both internal (e.g. congestion) and external (fatalities, air- as well as noise pollution, energy consumption, social and economic exclusion due to insufficient accessibility, space consumption, land separation), that are the main consequence of growing private motorization (adapted low density settlement patterns and segregated land-use distribution) and deficient public transport systems.

For this reason, municipalities and governments are strongly motivated to realign transport and urban planning policies in favor of more positive sustainable outcomes and to mitigate the above mentioned negative externalities. This shift can be seen in Iran's lowering of subsidies for fossil fuels and participation in cooperative projects like Young Cities, or Egypt's creation of Sustainable Transport plans, or the Arabian Peninsula's massive investments in public transportation.

6.1 Urban Transport at the Neighborhood Scale

As the smallest spatial unit, neighborhood level transportation planning forms an important contribution to the resulting characteristics of the transport system at the city level.

With the emergence of space-based economies of scale and the shift towards western planning paradigms, land-use patterns have spatially and functionally disintegrated, lengthening the average daily trip, especially the commute between work and home. In responding to this, neighborhood transport planning needs to consider four different types of daily transport flows:

- Originating traffic,
- Ending traffic,
- Originating and ending traffic,
- Through-going traffic.

Reducing all of the above flow types would mean that the provision of goods and services would have to be more distributed throughout a greater number of locations located closer to the sources of demand. However, reducing the operating costs of the institutions or business which provide good and services by allowing them to maximize production economies of scale in centralized locations outside of urban demand centers would increase traffic and trip length.

In this regard, it is the task of an efficient land-use distribution to balance concentration and dispersion between the interests of customers (for short trips) and the economy (in optimal cost-income ratios). The Theory of Central Places by Christaller provides an excellent classification system for goods and services according to their centrality in the city context. For example, a shopping center has a larger service area than a small grocery store. Considering the above mentioned transportation motives and their physical manifestation in a city context, planners can, to a certain extent, guide the length of all types of daily transportation flows. Thus, a sustainable approach would try to centralize traffic origins and destinations in the same neighborhood as much as possible.

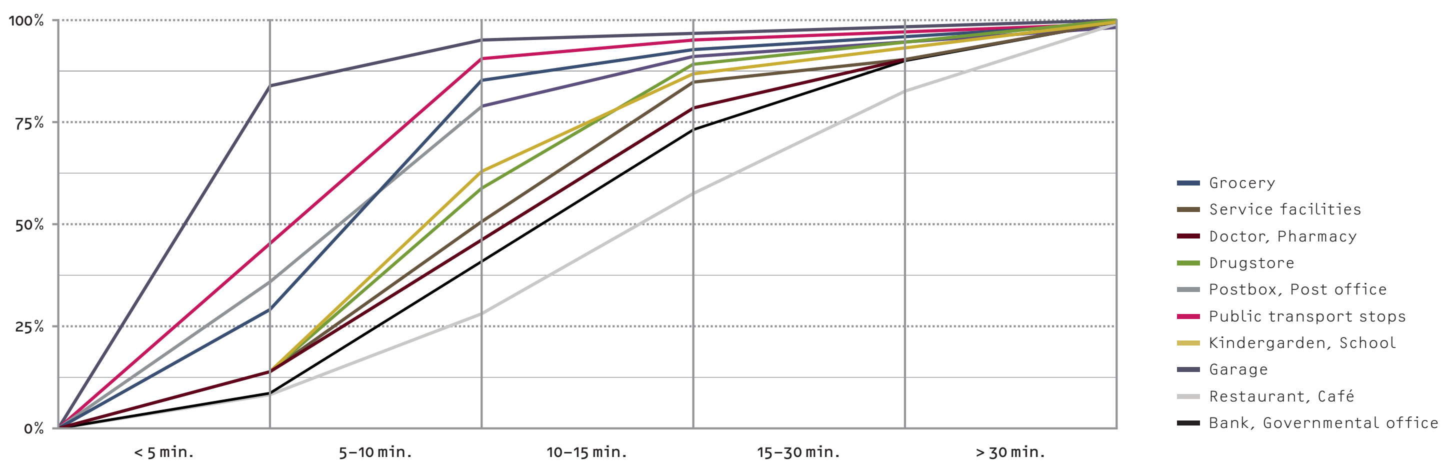


Fig. 54: Distribution of walking times for different purposes (Schnabel and Lohse 2011, p.67)

Moreover, the sustainable approach would try to shift as much transportation as possible towards walking, cycling, and Public Transport, as these have the least negative impact. In this regard, targeted manipulation of transport-mode choice is critical. Mode choice depends on the following criteria:

- Availability of a certain means of transport or necessary prerequisites (e.g. secure bicycle lanes, short trip-length to the next shopping facility),
- Accessibility of a certain means of transport,
- Personal and societal perception,
- Trip costs (e.g. measured in time or monetary units).

In order to support the use of environmentally-friendly transport modes, it is the job of the planner to ensure that walking, cycling, and Public Transport (PT) are more attractive than private vehicles in all four of the above criteria.

In a perfect system the customer should ask himself following question: Why should I take the car? Is there any advantage?

Taking the case of "walking" as the transport mode and a trip purpose of "shopping/procuring". In this instance, there needs to be an optimal connection between the individual's origin and their shopping destination. Walking trips are especially sensitive to trip length. In Germany the average walking trip is 1.1 km long, Fig. 54 illustrates how average trip lengths are connected to certain purposes (Schnabel and Lohse 2011). Moreover, pedestrians are also quite sensitive to accessibility shortfalls, long waiting times at crossings, path steepness, perceived barriers, and unattractive walking environments.

Nearly the same criteria are valid for cyclists and include the need for cyclist-specific facilities such as safety, separated bicycle lanes, and parking facilities. The main advantage of bicycles is that they make longer trips more accessible, e.g. the average trip-distance in Germany is 3.4 km, versus the 1.1 km for walking. However, in order to enable trips of longer distances, cycling-specific institutions and facilities are of central importance.

Regarding long-distance travel or daily commuting, public transport and cars are direct competitors with similar daily average trip-lengths (9.6 km car; 9.3 km PT) (Schnabel and Lohse 2011). Although, public transport use: by guaranteeing better accessibility (distance to PT stops) and lowering of cars (exclusion of car use in neighborhoods, longer distances to parking places).

6.2 Low Carbon Transport Planning Approaches for Neighborhoods

Every approach starts with the question:
What should daily traffic look like and? What is possible?
The Ideal Answer:
Optimal mobility and accessibility with the lowest level of negative internal and external effects.

In order to mitigate energy consumption and CO_2 emissions, the planned system and urban form need to provide optimal accessibility and mobility for non-motorized modes. In this regard, it is not important whether the planner is dealing with an already built environment or a brownfield. The following describes concept essentials which serve whose realization will need to be adapted to each unique site. In built areas, there may be restrictions for larger infrastructure changes. But most of the policies described below consist of "soft," more organization related, measures which enable significant changes in sustainable mobility patterns even in built environments.

Old city centers in agglomerations of the exhibit urban patterns are based on the structural model of the ancient Islamic city and its manifold variations. The general layout already fulfils many of the criteria for optimal walking and cycling accessibility, consisting of roads which dead-end into residential units and main streets which provide access to other neighborhoods, channeling through-going traffic.

Moreover, the ancient Islamic city model fulfills another important criterion: with the main suq in the center and smaller sub-suqs in every neighborhood, the provision of goods and services is already staggered according to their centrality, reducing average trip lengths (Scharfenort 2009). With recent modernization and industrialization, new challenges emerged and urban structures and functions adapted. The suqs (especially the main suq) lost their importance, the classical separation between living and working softened, the Central Business District (CBD) as the new center emerged and industrial estates developed in the hinterland of the cities (quite late, if a functional separation wasn't already introduced during the colonial era) (Scharfenort 2009).

port is by far the more energy-efficient and lower GHG emitter of the two, the car is heavily subsidized in municipal as well as governmental planning. An internalization of the external costs of traffic could help making the competition for customers a little bit fairer, such as reducing fuel subsidies or compensating for societal costs like illness due to noise- and air pollution or the sealed space necessary for parking facilities. Moreover, planning on a neighborhood level can heavily influence later public transport use.

In this regard, a low carbon transport approach in urban neighborhoods of the MENA has to make use of the knowledge that is already available in the region as well as address the urban transport challenges emerging from the rapid urbanization, globalization, and general westernization of urban agglomerations.

Consequently, planning for low carbon transport needs to consider the following aspects:

6.2.1 Demand Minimizing Land-Use Configuration (Mixed-Use)

In order to optimize livability and resource efficiency while reducing the demand for transportation, planning disciplines must coordinate from an early stage. This will allow for early consideration of transportation needs (accessibility of planned shops) and restrictions (limited amount of parking spaces, impossibilities to provide access). To bring origin and destination closer and reduce the number of overall trips, it is of utmost importance that as many of the low-centrality, daily consumed goods and services as possible are provided directly within the neighborhood (below ten minutes walking time). Land-uses that emerge out of the need for providing goods and services which require higher centrality should be located at the neighborhood's edges in order to improve accessibility by public transport or bicycle and to lower the amount of traffic.

6.2.2 Prioritization of Slow Modes

A prioritization of low-impact modes focuses on planning measures that consider the needs of pedestrians, cyclists, and public transport first, and then those of car users. In this planning method, the planner first creates an optimal network for pedestrians and cyclist and then adds facilities of additional modes of transport without negatively influencing the non-motorized modes. This means that a pedestrian crossing is more important than a parking place and that the street should be designed for safety and not for average capacities of motorized traffic.

6.2.3 Street- and Path Structures Guaranteeing Optimal Internal Connectivity

In the ancient Islamic city, privacy was an important factor. For that reason, a complex network of alleys was structured around larger neighborhood-connecting streets. In contrast, classical western planning policies align the built environment along drivable dead-end access ways. In order to reduce average trip lengths and lower walking distances, a compromise would be to break up the dead end systems for pedestrians and cyclists by respecting the minimal requirements for rescue and delivery vehicles. In a newly built environment, a sub-neighborhood would consist of several buildings that are grouped around a yard and are connected via paths to the next sub-neighborhood and to drivable streets or access ways. This grouping keeps the privacy inside the sub neighborhood, reduces the amount of sealed soil, and assures a critical population density that is a prerequisite for cost-efficient public transport.

6.2.4 Support of Public Transport

As already stated (i.e. for Germany), the average length of public transport trips is comparable to those of the car. For this reason, an approach that supports the use of public transport should outmatch those characteristics that are usually considered as the strengths of individual motorization. This means that public transport services should have shorter access and departure times than the walking time between car and destination/origin. As Fig. 54 illustrates, the acceptable distance should not exceed six minutes walking time. Inside the neighborhoods, departure times can be reduced by stop on demand. Generally, the system should consist of different categories. Small services, like mini-buses, can function as a feeder to the higher capacity system like a city-bus, light-rail, or metro and should also be the connection to the next neighborhood. This differentiation of services reduces the number of stops for high capacity services and, hence, the commuting time.

It is also of importance to assure inter modality between the different systems through the creation of Bike and Ride or Park and Ride facilities.

To improve the attractiveness of public transport and generate new users, clear and understandable marketing and barrier-free access to information on the services needs to be provided. Areas which are yet to be built or special target groups (e.g. moving families) would require additional campaigns or measures like mobility packages (providing informational brochures and test tickets for public transport in combination with assistance).

To keep the newly won users, it is of utmost importance to evaluate the offered service and assure that all quality standards are fulfilled for the whole system. As already stated, private motorization is growing rapidly in the MENA region, especially among the growing lower middle class. Until they first step into private motorization, this potential group of customers is often heavily dependant on informal public transport of low quality and security standards (e.g. line taxis, jitneys, mini-buses). Preventing them from taking that first step into motorization by providing an attractive system, targeted price policies, and information campaigns can significantly contribute to mitigation strategies.

6.2.5 Support Energy-Efficient Vehicles (Electric Vehicles, Low Consumption Vehicles)

Energy-efficient vehicles are one way to reduce energy-use, GHG emissions, and noise. Their use can be supported through different strategies. In some areas of cities in Northern Europe, there are accessibility limitations for vehicles that do not fulfill certain standards. Another strategy is to support the renewal of the car fleet by offering special incentives (e.g. certain years with lower taxes).

Support of electric vehicles has to be done carefully. Most of the vehicles are still not as efficient as combustion-engine vehicles in terms of energy-use. Moreover, the vehicle can only be considered environmentally-friendly when its energy is produced from renewable sources. Finally, the use of electric vehicles demands certain infrastructure, especially a sufficient power grid—which often does not exist in cities of less developed countries.

6.2.6 Traffic Safety

Traffic safety is an important issue, especially if it is related to a strategy that prioritizes low-impact modes. In all transport systems, pedestrians and cyclists are the weakest traffic participants. The level of traffic safety can be a deciding factor for cyclists and pedestrians.

It is important to assure that: lines of sight are kept free, there are a sufficient number of crossings, walking phases at crossings cater to the slowest participant, the speed of motorized vehicles is reduced inside neighborhoods, and bicycle lanes are separated from motorized traffic. The realization of most of these aspects can be supported by introducing construction standards for new projects.

6.2.7 Barrier Free Access

Barrier free access can be achieved for vehicles by reserving a certain amount of parking places next to important destinations. The opportunity to reserve a specific parking spot next to one's own flat is a proved and tested strategy. For people who do not depend on motorized vehicles, the planner has to assure that: steep inclinations are minimized (less than 12%), streets are kept free of waste, sidewalks and, crossings are equipped with a guiding system (ripple plates) and traffic lights with a noise signal system. In most cities of developing countries, high curbs and pedestrian bridges are obstacles for people with disabilities and need to be changed to provide barrier-free access.

6.2.8 Noise Protection

Noise protection can be achieved through reducing the average speed, renewing the car fleet, implementing noise reducing street covers, and limiting the times of access for certain vehicle types (trucks, pick-ups). In some cities, specific time intervals are reserved for noisy activities such as delivery, waste collection, etc. This can also be an appropriate measure for reducing traffic peaks by setting the time for deliveries outside the morning commuting peak.

6.2.9 Integration of Hard and Soft Policy Measures

The combined use of hard and soft measures in concert with 'push' and 'pull' strategies is central to an integrated planning strategy. All above mentioned examples can be assigned to one of four fields on a matrix of these measure and strategy types, as in Fig. 55. Most planning approaches, especially in developing countries, focus on money-intensive hard or construction-based solutions. Yet, in most cases it is a combination of hard (construction-focused) and soft (organization-management- information focused) measures that decides the success of a plan. In the end, it is the decision of the individual whether or not to use a car or public transport, and this decision is mostly based on perception of the system which, in turn, is mainly related to available information as provided by soft-policies.

The "push" and "pull" strategies illustrate how measures can have a direct influence on the perceived attractiveness of transport systems.

Transport modes compete with each other. This is especially valid in the case of automobiles and public transport. Changing the attractiveness of modes is not always related to the improvement of another mode, it can also be guided by a planner who deliberately lowers the attractiveness of one mode in order to incentivize a shift to the other. In the case of cars and public transport, this could be to place parking places farther than the next public transport stop or to internalize the external costs caused by private vehicles.

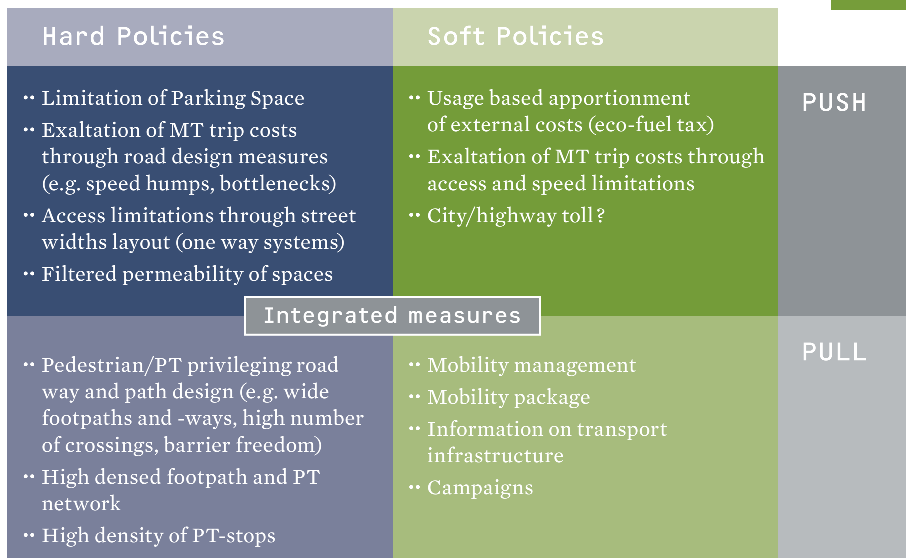


Fig. 55: Transport approach—possible instruments (Arndt 2011)

7 Planning Urban Green and Open Spaces as a Contribution to Sustainable and Livable Cities

Bernd Demuth | Sara von Eitzen

Scientific studies predict a global temperature rise between 1.1 and 6.4°C and an increase of extreme weather events due to climate change (IPCC 2007, p. 45). This will have serious consequences for inhabitants of cities (e.g. formation of heat islands). Significant, negative impacts on health and quality of life are expected for city inhabitants. In terms of climate change mitigation and adaptation to its possibly negative consequences in an urban environment, green and open spaces are particularly important. The ecosystem services provided by green and open spaces can, for example, reduce the predicted impacts on health and life quality.

> ***"Urban greening has been proposed as one approach to mitigate the human health consequences of increased temperatures resulting from climate change."***
> (Bowler 2010, p. 147)

However, many urbanites are not aware of the positive effects resulting from biotic and abiotic processes in green and open spaces since these are not easily discernible. In order to arouse the interest and openness of urban inhabitants and sectoral planners, ecosystem services are presented more thoroughly in the following section IV 7.1. Worldwide, full understanding and appreciation of these "free services" is still in an early stage. A legal basis is needed to ensure legally binding regulations of green and open spaces in order to protect ecosystem services and their benefits (see IV 7.2).

7.1 Urban Ecosystem Services

Ecosystem services are defined by the Millennium Ecosystem Assessment (2005, V) as "the benefits people obtain from ecosystems"—these are divided into four categories of services:

- Provisioning Services (e.g. of food, fresh water, and other goods).
- Regulating Services (e.g. of climate, water and pollination),
- Supporting Services (e.g. soil formation and nutrient cycling), and
- Cultural Services (e.g. educational, aesthetic, cultural heritage values and recreation).

In urban areas these ecosystem services are mainly provided by public, semi-public, and private green and open spaces. In this context the overlap of ecosystem services has to be emphasized: in most cases, several ecosystem services can be carried out by the same area. This multifunctionality of urban green and open spaces underlines their essential importance.

7.1.1 Provisioning Services

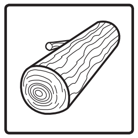
Supply of food

Urban ecosystems can supply urban populations with supplementary plant and animal food products. Beyond common place agricultural and horticultural cultivation as well as small-scale animal husbandry, food supply can also encompass novel cultivation and production types, e.g. urban aquaculture, hydroponic cultivation systems, and even vertical farming. For such purposes, housing block and neighborhood levels can re-use water and nutrient resources from sewage. Not only would this utilize nutrients contained in, and thus purify, sewage, but it would also regionalize energy and material cycles. Novel agricultural cultivation methods feature a high degree of intensification and mechanization and therefore they possess a rather "artificial" character. However, they are composed of the natural abiotic and biotic processes which are the basis of the ecosystem services and which create a new source of food supply at an urban local level.

Benefits to humans:

- Contribution to food security through increased self-supply and creation of additional income through sales revenue;
- Potential tourism and cultural significance through the preservation and marketing of regional specialties;
- Contribution to climate change mitigation by shortening the length and decreasing the number of transport routes.

Supply of raw material

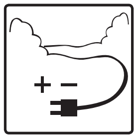


Urban ecosystems can supply renewable raw materials (as well basic material for medicine) from plant and animal products, creating urban raw material production at a local level.

Benefits to humans:

- Supply of materials for consumer goods;
- Increasing self-supply and creation of additional income through sales revenue;
- Medical supply through medicinal plant and animal substances;
- Contribution to climate change mitigation by through shortening the length and decreasing the number of transport routes.

Supply of energy



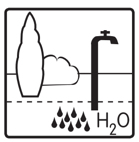
Urban ecosystems can supply urban inhabitants with a source of renewable energy from biogas plants through which organic waste of households is recycled. In the face of steadily growing agglomerations, urban production of renewable energy is becoming more and more important.

The energy production of urban biogas plants with 24-hour operation can make a significant contribution to the basic energy needs of urban inhabitants. The overarching energy goal is to produce the maximum amount of energy directly where it is needed—within the urban space at a local level.

Benefits to humans:

- Increasing self-supply of renewable energy,
- Contribution to climate change mitigation by reducing fossil energy use.

Supply of water



The groundwater recharge functions of infiltration, filtering, and buffering, as well as the decomposition of waste products by soil organisms, play an important role in the sustainable supply of water for urban populations. Unsealed soil surfaces and non-contaminated soils are necessary prerequisites for the supply of soil-based ecosystem services.

Benefits to humans:

- Security of drinking and process water supply for private households, trade, and industry;
- Irrigation of urban vegetation.

Urban Form

In terms of mitigation and adaptation to climate change and its potential negative impacts on the urban environment, green and open spaces are particularly important. The ecosystem services provided by green and open spaces can reduce for example, the expected impacts on health and life quality.

Urban Resources

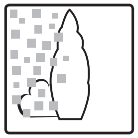
Urban Technology

Urban Governance

The benefits of urban green spaces are particularly important for groups which are socially disadvantaged.

7.1.2 Regulating Services

Air purification

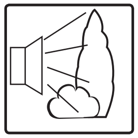


By filtering out particles and pollutants, urban vegetation can (alongside technical measures) significantly improve urban air quality.

Benefits to humans:

- Improved urban air quality: lower pollution load and improvement of health (e.g. protection against respiratory diseases).

Noise reduction

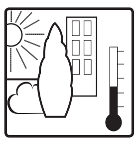


Beyond a, rather low, physical noise reduction, vegetation's optical shielding of the noise source creates a psychological reduction of noise perception. Larger green and open spaces create further noise reductions by increasing the distance between noise sources.

Benefits to humans:

- Reduction of noise exposure: protection against hearing impairment and noise-induced stress;
- Psychological relief through decreased perception of noise levels
- Increased real estate value.

Regulation of the urban climate

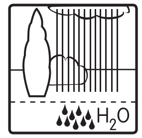


Urban green and open spaces help reduce intra-urban daytime temperature peaks through transpiration of vegetation and evaporation from moist soil, as well as by casting shadows. These services require sufficient water availability, which is why drought-tolerant (generally local) plant species should be used, especially in semi-arid areas. The cooling effect can be felt not only within green and open spaces but also, depending on local conditions, within neighboring housing. The provision of nocturnal cooling has a significant importance for health issues. Night temperatures above 20°C have a negative impact on human well-being and increase health risks when persisting for the longer term. An adequate amount of green and open spaces, without extensive tree canopies, is necessary if reduction of intra-urban night temperatures is to be achieved by nocturnal radiative cooling.

Benefits to humans:

- Local reduction of temperature peaks (urban heat island) within green and open spaces as well as in neighboring housing;
- Energy saving (e.g. reduced demand for air conditioning);
- Cooling of night temperatures through radiative cooling of open areas
- Alleviation of extreme events (periods of severe drought and heat).

Retention and storage of rain water

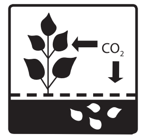


The storage capacity of ecosystems retains precipitation in both soil and vegetation. Reducing surface runoff can help avoid the detrimental effects of erosion, allowing more water to be stored in the soil. In turn, soil stored water available for native vegetation reduces the need for irrigation during drier periods.

Benefits to humans:

- Mitigation of extreme events (heavy rainfall, floods);
- Erosion protection through reduction of surface run-off;
- Storage of water (for vegetation, reduction of irrigation demand).

Carbon binding



Atmospheric carbon can be bound in the soil layer as well as in both above- and belowground plant components. However, water availability is a limiting factor, meaning that semi-arid climates have lower carbon binding in comparison to moderate climates. Carbon binding as an additional positive side effect of urban open spaces should be implemented through local, drought-tolerant vegetation.

Benefit to humans:

- Small-scale contribution to climate mitigation.

7.1.3 Cultural Services

Supply of local areas for recreation

A suitable quantity and quality of public green and open spaces provide urban inhabitants with places for recreation and relaxation which are close to their homes.

Benefits to humans:

- Contribution to local recreation opportunities;
- Increased real estate value of neighboring housing;
- Additional attractiveness for tourism.

Supply of green spaces for culture and education

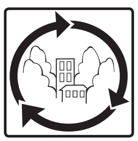
Public green and open spaces can make a broad and diverse contribution to education and the mediation of cultural values through guided tours, educational trails, environmental education facilities, and so forth. They also offer individuals space for personal and religious reflection.

Benefits to humans:

- Enabling the experience of nature;
- Aesthetic enjoyment, inspiration for artistic services, cultural-historical importance;
- Importance for religious contemplation and spirituality;
- Environmental education: the acquisition of home and natural-historical knowledge, as well an understanding of environmental science;
- Enabling of identity-generating experiences, support of personal development;
- Space for creative and sports activities;
- Inspiration for orienting science towards natural models (e.g. bionics)
- Places for ethical and religious inspiration;
- Additional attractiveness for tourism;
- Increased real estate value of neighboring housing.

7.1.4 Supporting Services

Maintenance of the capacity of urban ecosystems



Maintenance of abiotic and biotic processes is an essential basis for all ecosystem services. This is especially important given the way basic ecosystem services will be altered by climate change with potential negative impacts on human well-being.

> ***"Drivers of global environmental change (e.g. land-use change or climate change) can directly pose health risks or impair ecosystem services that subsequently influence health."***
>
> (Myers and Patz 2007, p. 227)

Preservation of ecosystems as fundamental for humans:

- Preservation of biodiversity
- Habitat supply
- Biological pest control
- Soil development
- Reproduction of all living organisms within an ecosystem
- Self-regulating, self-sustaining services

7.1.5 Environmental Justice—Opportunities by Urban Green and Open Spaces

Green and open spaces can help minimize health risks in the urban environment (e.g. air pollutants, noise, heat and aridity/drought). They also have great potential for increasing psychological, physiological and social well-being. These contributions translate into reduced healthcare costs. Health related benefits of urban green spaces are particularly important for socially disadvantaged groups. Low income and low social status inhabitants often lack the means to improve their immediate quality of life (e.g. by energy-intensive cooling of the flat or by leaving the city during thermal inversion). Moreover, socially disadvantaged urban populations tend to have substandard access to green and open spaces, negatively affecting their quality of life. Both aspects, health and social situation, are discussed under the topic of environmental justice.

With this in mind, the services of urban ecosystems take on an increasing importance for the life quality of urban inhabitants, from well-being to health. In particular, the circumstances of socially disadvantaged groups can be improved by supplying access to a minimum of 7 m² per capita of public green and open spaces. Both the creation and protection of urban green and open spaces are crucial if the positive social and health impacts of ecosystem services are to be preserved.

7.2 Binding Designation of Environmental and Nature Conservation Concerns as a Contribution to Sustainable Cities

The planning of sustainable cities should include measures for mitigation of and adaptation to climate change in order to prevent further rising of global temperatures, as well as to preserve and possibly improve quality of life. Beyond measures in the construction and transport sector, urban green and open spaces are essential for the quality of life of city inhabitants and for the preservation of natural resources (see chapter IV 7.1).

> ***"As the cities will determine the fate of the remaining biodiversity of our planet, there is a strong view that the battle for life on Earth will be won or lost in the cities."***
>
> (Djoghlaf 2007, p. 4)

Sustainable urban planning must incorporate laws which ensure: the existence and maintenance of a sufficient amount of green and open spaces; and, associated with that, the consideration of environmental and nature conservation concerns in the planning process.

7.2.1 Preconditions for the Efficacy of Environmental Law

There are a multitude of legal agreements for the protection and maintenance of the environment at the international level. However, it is national implementation which permits the legal protection of environmental concerns in federal, regional, and municipal planning. Additionally, the inclusion of environmental concerns in the laws of functional departments whose activities impact the environment (e.g. construction and transport laws) is also of vital importance. Moreover, regulations must be sufficiently detailed and precise in order to ensure all necessary legal protection of environmental and nature conservation concerns are incorporated in planning processes.

In many emerging and developing countries in the MENA region, including in Iran, such precision is largely missing: the legal basis for environmental protection lacks sufficient regulatory depth. The following sections draws from the German Federal Building Code (BauGB § 9) in creating suggestions for improving environmental consideration in Iran's regulatory structure.

7.2.2 Inclusion of Environmental Concerns in the German Federal Building Code

German urban land-use planning, subject to the Federal Building Code (BauGB), serves as an example of sustainable urban development. The goal of the code is to create a livable urban environment while protecting and developing local natural resources (BauGB § 1). The Federal Building Code precisely regulates land-use planning to ensure the provision of green and open spaces to meet environmental concerns and as an essential part of healthy, livable urban environments. Section 9 of the Code allows for explicit, legally binding regulations which require green and open spaces to be incorporated in land-use plans.

7.2.3 Possibilities for Planting and Maintaining Green and Open Spaces in a Legally Binding Land-use Plan

Regulations for planting and maintaining green and open spaces serve to increase the amount of greenery in the urban fabric, help with the formation of the townscape, structure and shield building areas, as well as form the transitions between settlements and rural areas. Local climate concerns, like the ecosystem service of fresh air, can also justify regulations for planting and maintenance. They can also be designated as part of building facilities, providing a legal basis for façade and rooftop greenings as well as the greening of noise protection embankments.

The Federal Building Code even specifies the maintenance of smaller waters (where the water laws do not apply)—e.g. when they are relevant for the urban and landscape scenery, but also when they are necessary for climate protection.

Binding regulations for the planting and maintenance of public and private green areas include written descriptions and concrete identification in a map. This allows precise quantitative and qualitative requirements which may include the following instructions:

- Planting of particular tree and shrub species (plant lists),
- Density of greenery (number of plants per m²),
- Minimum standards (size, trunk diameter, quality),
- Defining the ratio of different species (as well as seed mix).

Such legally based protection and development of urban green and open spaces is illustrated with example applications in Chapter VI 7.

Figures in this section: © Strich für Strich, Diana Baur

8 Using Environmental Assessment to Bring Environmental Concerns and Impact Mitigation into Urban Development

Holger Ohlenburg

Environmental Assessments leads to more sustainable, better adapted, and more widely accepted planning solutions.

The physical environment is composed of flora, fauna, soil, water, climate/air, and visual landscape as well as cultural and material assets and goods. These components combine to provide a multiplicity of ecological and non-ecological functions and services, e.g. acting as habitat, providing clean water, filtering and chemical buffering, serving as recreational space, documenting cultural heritage, etc. (see IV 7; cp. Haaren 2004). The aim of sustainable urban development is to minimize negative impacts on these factors and functions, preserving their benefits for current and future generations. This is the central task of Environmental Assessment, which is referred to as Environmental Impact Assessment (EIA) in the context of projects, and as "Strategic Environmental Assessment" (SEA) in the context of plans, programs, and policies.

SEA is defined as a "participative approach to place the environmental and social aspects in the centre of the decision-making and the implementation processes at a strategic level."

(Mercier and Ahmed 2004)

In an urban planning context, SEAs can contribute the following goals, tasks, and functions:

- Incorporation of the precautionary principle and conflict resolution at an early stage,
- Comprehensive consideration of environmental impacts,
- Consideration of planning alternatives,
- Support and validation for decision makers (optimization of decision-making through inclusion of public participation and a documented decision making process),
- Optimization of planning solutions in relation to environmental concerns, and
- Improvement of the municipal planning process.

8.1 Environmental Assessment Process in an Urban Planning Context

SEAs of urban land-use plans run parallel to the formal urban planning process—the German detailed plan preparation process serves here as an exemplary model (see Fig. 56). There is a "scoping process" at the very beginning of an urban development process (e.g. after the decision to prepare a detailed plan for developing an urban quarter). Relevant actors meet one or more times to discuss and fix:

- the potential environmental impacts of the development (incl. its intensity),
- what environmental data is already available,
- what data will need to be gathered,
- how it should be gathered (e.g. which method and for which period of time), and
- how it should be analyzed.

Based on these decisions a preliminary draft of the plan and a first draft of the environmental report are prepared. Under certain preconditions, an "early participation" takes place based on these documents. Authorities and the public are informed about the development project and can give feedback which can be considered during this first step. Otherwise, the municipality council publishes both drafts for a one month formal participation process, where authorities, other stakeholders who are responsible for public concerns, and the general public can make statements concerning the plan. In the following step, the municipality has to weigh all statements and concerns against each other. If this results in additional plan modifications, then the formal participation step will need to be repeated.

The result of this process is a detailed plan with an integrated environmental report which takes stakeholder concerns into consideration. After the formal adoption and enactment by the municipality council, the public is informed about the decision and how statements from the participation step have been considered in the final version of the plan. Part of the environmental report is an environmental monitoring concept which serves as the basis for the monitoring process during plan realization (see IV 8.6).

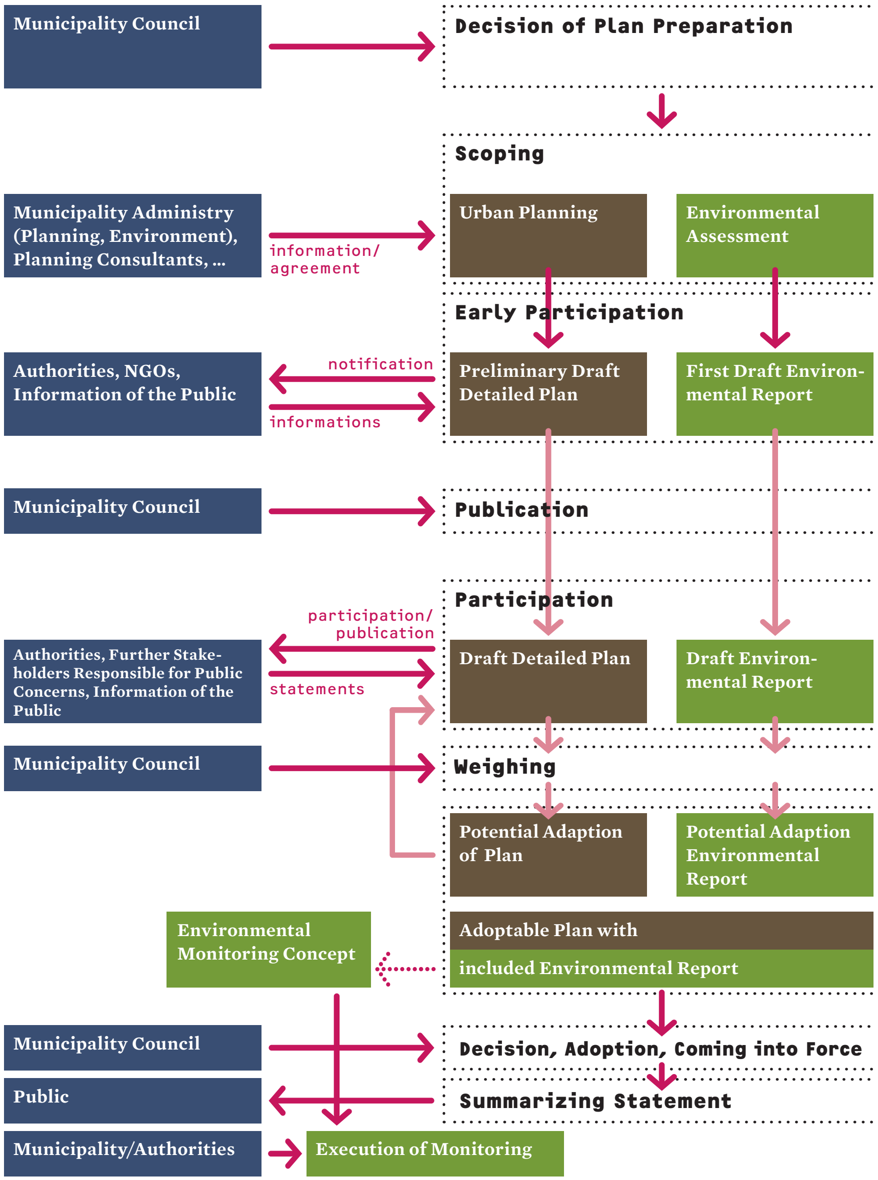


Fig. 56: Formal steps of the German detailed plan preparation process with integrated Environmental Assessment (Umweltministerium Mecklenburg-Vorpommern 2005, modified and translated)

Urban Form

- Enabling enhancements of the sustainability of the final urban layout and design.

Urban Resources

- Protection, maintenance, and development of the environment;
- Mitigation of impacts on what are called environmental factors: flora, fauna, soil, water, climate/air, and visual landscape as well as cultural and material assets/goods and ecosystem functions.

Urban Technology

Urban Governance

- Incorporation of the precautionary principle and conflict resolution at an early stage;
- Consideration of environmental impacts and planning alternatives;
- Support and validation for decision makers (optimization of decision-making through inclusion of public participation and a documented decision making process);
- Improvement of the municipal planning process.

"Basically, policies, programmes and projects are less likely to fail if the public is involved."

(UNEP 2004, p. 65)

Although it requires extra time and investment, the consultation process with public participation is an important part of environmental assessments Evaluations of previously implemented policies, programs, and projects have made clear the following lessons (UNEP 2004):

- Early and planned public involvement enhances the design of policies, programs, and projects;
- Policies, programs, and projects with public involvement are more likely to achieve their objectives, avoid costly delays in appraisal, and circumvent difficulties in obtaining necessary permits or licenses.

8.2 Analysis and Reporting in Environmental Assessment

Environmental Assessment means analyzing, describing, and evaluating the environment. Proper analysis of the impacts of plans and projects on environmental factors enables planners to take precautionary steps to avoid, minimize, and compensate for the undesirable effects of urban development.

In practice, planning authorities often assign environmental planning consultants to conduct an "Environmental Impact Study" (EIS). This consists of an analysis and documentation of the current status quo based on available data, and if needed, additional surveys, of the following factors: flora, fauna, soil, groundwater/surface water, climate/air, human health, landscape, and cultural goods. Relevant protection needs and sensitivities towards impacts are also assessed. Furthermore, the likely adverse impacts of the plan or project are analyzed, including predictions of the environment's development both with and without the plan or project realization.

Based on the predicted impacts, mitigation measures are proposed to avoid and minimize environmental impacts (plan modifications). Further proposals for environmental enhancement measures are made to compensate any residual environmental impacts (cp. IV 8.3).

The EIS forms the basis for the formal Environmental Report, where information and analysis is summarized in a standardized form, according to the legal requirements of the planning and building code (see Fig. 57). The environmental report, with its avoidance, minimization, and compensation measures (including monitoring) becomes legally binding with the formal approval of the land-use plan.

Environmental assessment supports sustainable urban development and can support the consideration of environmental protection concerns. This brings environmental aspects into the planning process as early as possible by making them accessible and understandable for the different planning actors, especially the decision makers (Ohlenburg et al. 2012d).

1 Introduction

a) Summary of the content and main aims of the urban development plan with information about the location, character, and extent of development, incl. space demand
b) Description of aims of environmental protection defined in legal regulations and superior plans with relevance for the urban development plan and how those has been considered

2 Description and Evaluation of the Environment and Prediction of Impacts

a) Information about the current state of the natural environment (flora, fauna, soil, water, air and climate, landscape, as well as human health, and cultural and material assets)
b) Planned measures for avoidance, minimization, and compensation of likely adverse environmental impacts
c) Prediction of environmental impacts caused by plan realization and of environmental development if the plan were not realized (non-built alternative)
d) Possible planning alternatives

3 Further Information

a) Description of the applied methods and remarks concerning difficulties and lack of information.
b) Description of measures to monitor the environmental impacts during the implementation phase
c) Non-technical generally understandable summary

Fig. 57: Content of the Environmental Report for an urban development plan according to the German Federal Building Code

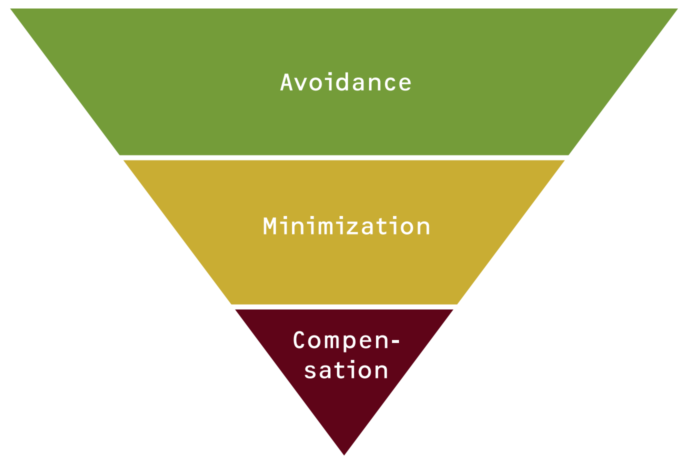


Fig. 58: The mitigation hierarchy (Darbi et al. 2010)

8.3 Environmental Assessment as a Tool for Mitigation and Compensation of Environmental Impacts

Residual adverse environmental impacts, which cannot be avoided or minimized by plan or project modifications should be compensated by environmental enhancement measures.

Internationally, developing measures to avoid, mitigate, and in some cases even compensate for environmental impacts are planning tasks for which the environmental assessment of urban land-use plans is responsible. In regards to the sustainability, the German planning and building legislation is closely connected with German nature conservation legislation. It includes regulations for environmental impact mitigation and environmental compensation ("Impact Mitigation Regulation"). The Impact Mitigation Regulation aims for a "no net loss" of environmental functions when realizing development projects. The regulation is based on both the well known „polluter pays principle" and the „mitigation hierarchy" (see Fig. 58). Both principles are the basis for a variety of mitigation and compensation approaches implemented around the world (cp. e.g. Darbi et al. 2010; Dickie et al. 2010).

Adverse environmental impacts, which cannot be (firstly) avoided or (secondly) minimized, should be compensated by environmental enhancement measures. The developer of a project (as the polluter) is obliged to implement (i.e. realize and pay for) these measures. The no net loss target means that the environmental impacts caused by the project are balanced or outweighed by measures taken to avoid and minimize the project's impacts, to undertake on-site restoration and, finally, to offset the residual impacts, so that no loss remains.

Whenever possible, the compensation measures should replace the same functions and enhance the same environmental factor which has been destroyed or impaired (in-kind measures). Furthermore, the compensation measures should be realized in a close spatial relationship to the impacts (on-site measures). Out-of-kind and off-site measures are of secondary priority. However, in the urban context, it is not always possible to find and achieve access to spaces which lay close to the impacted areas and which have the potential for enhancement measures. Therefore, activities which enhance the overall condition of impacted environmental factors and/or ecosystem functions are suitable as compensation measures. Examples are the (re-)creation of habitats, planting obligations, and maintenance measures for reaching a more valuable biotope status. Ideally, planned measures should be "complex measures" and enhance different environmental functions at the same time.

8.4 Legally Binding Designations as Preconditions for Realization

A common way to regulate compensation measures in relation to urban development projects is the designation of areas and measures within the legally binding detailed plan, although contracts between the responsible planning authority and developers are also suitable.

The German detailed plan methodology enables the designation of compensation measures both on the plots adjacent to the buildings (see A in Fig. 59), for spaces with other uses in the detailed plan area (see B in Fig. 59), as well as on spaces off the site of the detailed plan area (see C in Fig. 59). The off-site compensation measures can also be regulated in another legally binding land-use plan or via binding contracts.

A detailed plan land-use designation especially suitable for compensation measures is "open and green space". German detailed plan legislation provides an even more suitable designation: „areas and measures for protection, maintenance, and development of the natural environment and landscape". Public spaces should be given priority, however, private spaces may be used where appropriate—in the latter case, sites and measures should be secured by additional contracts. In developing case-by-case compensation measures, expert and local knowledge should be taken into account wherever possible. For further details on designations in detailed plans see Chapter IV 7.2.

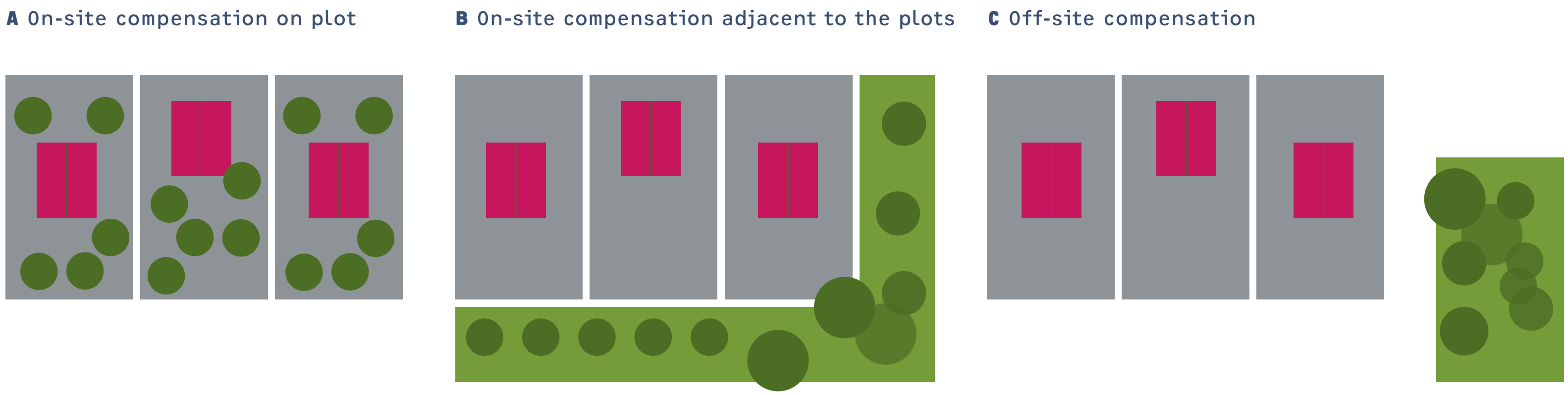


Fig. 59: Types of environmental compensation measure designations according to the German Building Code (Busse et al. 2004, modified)

8.5 Planning and Developing Compensation Measures

Areas for compensation measures should have a certain minimum size to be counted as such. Areas which are too small would not fulfill environmental functions to the same extent as larger ones (e.g. habitat function for certain animal species). However, large areas are often not available in the urban context, making a certain flexibility appropriate.

Compensation measures are those which enhance the natural environment and landscape. They should be adapted to local soil, climate, and water conditions and should replace the environmental functions impaired by the project. When ever possible, measures which support of multiplicity of environmental functions should be developed and realized.

The following measures will generally be suitable for compensating negative environmental impacts and ensuring the protection, development, and maintenance of the environment:

- Development of biotopes as a habitat for distinctive animal and plant species;
- Measures for the enrichment of biotopes;
- Reducing the intensity of use (e.g. agricultural use);
- Soil saving measures and soil replacement;
- Planting measures.

In an urban context, compensation measures can often fulfill both environmental protection and recreational purposes. However, planners need to be careful about ensuring that the measures support the environmental functions which have been destroyed or impacted by the project.

8.6 Monitoring

> ***Monitoring, as part of Environmental Assessments, enables long term supervision of the plan or project realization for securing environmental mitigation and compensation measures.***

A monitoring system, as part of the approved environmental assessment, enables verification of predicted impacts as well as the identification of unpredicted ones. It should also secure the realization of compensation measures and ensure that the implemented measures fulfill their intended functions. This kind of environmental monitoring is not to mistaken for the monitoring approaches presented in Chapter IV 10.

9 Citizen Participation in Planning

Angela Jain

Today, public participation and stakeholder involvement is an important success factor for economic, cultural, political, social, and societal processes. Participation means that all relevant persons and groups take part in: a) the detection and ranking of problems, b) deliberation and the carving out of working solutions, and c) preparation for political decision-making. Participation creates motivation, commitment, responsibility, and trust while improving the acceptance and legitimacy of decisions.

It is increasingly acknowledged that "political authorities should govern not only by means of traditional hierarchical authority but also by working together with the private sector and civil society to achieve desired political goals for urban development" (Falleth and Hansen 2011, p. 4). This thinking is creating a shift from "government to governance" (Rhodes 1997).

In planning, citizen participation can be used to generate demand-driven ideas and concepts which strengthen planning results by integrating the perspectives of users (see Leadbeater 2004; Parker 2007; Duffy 2007). For example, unlike what many transport engineers assume, the choice of the transport mode depends not just on time and costs, but also on accessibility, service quality, cultural aspects, and so on. However, these aspects are hard to quantify, and their qualitative aspects will change by user group (including elderly people, parents with children, disabled).

Participation is considered "a tool for reforming public services and for providing services that are better suited to people's needs and that are more efficient" (Brodie et al. 2009, p. 6).

9.1 Involving Neighborhoods and Communities

A key component of this approach, according to government, is to improve the design and responsiveness of services and thereby improve outcomes such as social inclusion, equality, and satisfaction (Foot 2009, p. 4). It integrates both the community and the individual as "key to the vision of more responsive services and increased citizen satisfaction in their locality" (Blake et al. 2008, p. 10). In the MENA region, communities or individuals are not currently involved in strategic planning, they have no role, for instance, in urban upgrading or neighborhood rehabilitation. However, "it is generally recognized that community participation ensures more effective results, and mobilizing community initiatives can lower the overall financial burden of upgrading projects" (UN-Habitat 2011, p. 2). Following the democratic awakening in the MENA region, the countries gain great opportunities to engage local communities as partners in urban upgrading schemes. In Tunisia for instance, civil society is still weak, but with the support of neighborhood associations it could quickly evolve. "A number of community participation mechanisms can be grafted onto upgrading programs, including monitoring and evaluation of projects and even participatory budgeting" (Ibid., p. 3).

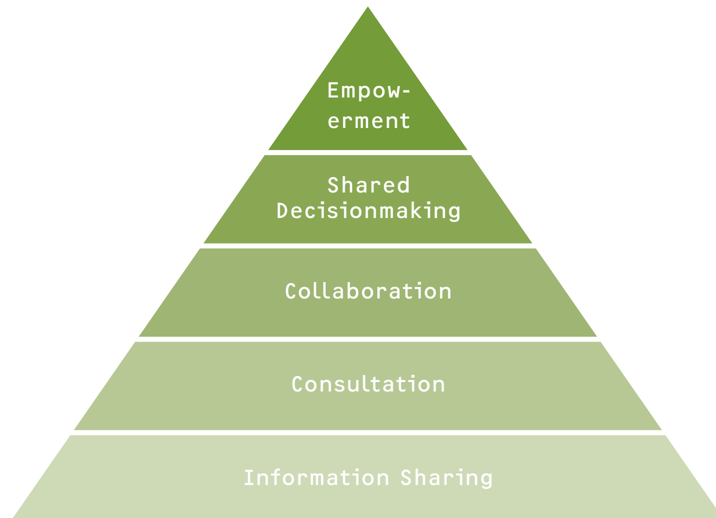


Fig. 60: Levels of participation (based on Brinkerhoff and Goldsmith 2000, p.5)

9.2 Levels of Public Participation

Usually, the concept of participation consists of different levels, from relatively passive modes to active ones. According to Brinkerhoff and Goldsmith (2000), these levels are: Information Sharing, Consultation, Collaboration, Shared Decision-Making, and Empowerment (see Fig. 60).

At the first level, the information flow is one-directional. The initiator (e.g. municipality) provides information about intended plans.

Consultation implies a two-way flow of information as well as an exchange of ideas between the initiator and participants/ stakeholders. At the third level, the initiator invites other groups or participants to collaborative consultation while retaining the authority to make the final decision. At the next level, the initiator shares the responsibility of decision making with the other involved parties. At the final level, the ability to make decisions is completely surrendered to the participants—as in the case of a referendum (Brinkerhoff and Goldsmith 2000, p. 5).

Public participation is a mandatory element in many formal planning processes, including planning approval procedures for road infrastructure or land development plans (cp. IV 8). The intention of these legally binding forms of participation is to safeguard the property rights of the citizens which the plans affect.

Planning results will be improved and planning decisions will be closer to the needs and wishes of citizens if citizen and stakeholder participation takes place earlier in the process—in the initial, informal stage, before formal regulation.

9.3 Examples of participation in urban planning processes

The following case studies mostly focus on transport planning; they help to outline the basic ideas and opportunities of early and informal types of citizen participation.

9.3.1 Citizens' juries on public transport (Example: Bürgergutachten üstra, Hanover 1996)

In order to provide planning security for future transport development, the Hannover transport company üstra had an open discussion with city residents on the current and future requirements for being a customer-oriented company and creating an attractive public transport system.

Formal Participative Procedures	Informal (cooperative) Participatory Practices	Informal Dialogue
·· required by law ·· fixed content ·· fixed procedure ·· formal documentation ·· participation subject to formal conditions ·· legal action possible	·· voluntary ·· standardized schedule ·· stimulate dialogue ·· promote mutual understanding and agreement ·· promote creativity ·· lends publicity to results	·· voluntary ·· any theme, any format ·· based on personal contacts ·· free exchange of views ·· "internal affair" ·· no public documentation

Fig. 61: Archetypes of participative processes

The company chose the "citizen jury" method for this participative process:

- participants were randomly selected,
- the process lasted two to four days,
- participants were released from work and remunerated,
- introductory presentations were given by experts,

Urban Form

Urban Resources

Urban Technology

Urban Governance

Citizen participation in planning can not only help to improve the service quality of urban infrastructure, but also to catalyze an integrated approach to planning. The citizen perspective can highlight the usability of architecture, urban form, transport and mobility, use of energy and water, landscape, and more in their everyday life. By incorporating the citizens or users' needs and demands, planning sectors can benefit from a more holistic view.

- unbiased consultations only among citizens,
- topics were worked on independently in small groups,
- results were summarized in a Citizens' Report.

This process design has a high probability of creating results which serve the good of society as a whole over individual interests. In Hanover, twelve planning cells were executed with 25 participants each, guided by professional facilitation and supported by specialized process coaches. During the four days of discussion, several hundred practical recommendations were developed. The results and prioritized recommendations were summarized in a Citizens' Report for the initiator of the participative process, the üstra transport enterprise. As soon as the recommendations were published, their implementation was accompanied by an intensive dialogue between the citizen experts and the employees of the public transportation authority. These implementation activities have a two-fold benefit: optimizing citizen expertise as an instrument for planning improvement, and supporting the internal innovative management of the public transportation authority (Sinnig 1999).

9.3.2 Passenger Advisory Boards (Example: "MoBiel", Bielefeld since 2002)

User advisory boards were developed in German public transport in the late 1980s. They are a permanent forum for consultation on important issues of service development, including: network, quality standards, design of timetables and stops, security, problems with noise, and events of interest. Today, about 100 boards are in existence. They are not required by law, but are usually voluntarily initiated by the transport provider. According to Schiefelbusch and Dienel (2009, p. 168) these boards:

- have an advisory role,
- are composed of members who are mainly public transport users and/or members of organizations representing user interests,
- are set up on a long-term or permanent basis,
- express and discuss users' views on public transport, both on current matters and future plans,
- have some formal 'foundation' due to their links to an operator or transport authority.

Most boards consist of 20 to 30 "representative members," with a balanced representation of different socio-demographic and special interest groups (elderly, youth, disabled, etc.).

In "MoBiel" for example, twelve members alternate every two years. This advisory board came into existence because the transport provider wanted to respond to customer demands in a more comprehensive way than solely by complaint management. Two assistants of the customer service department moderate the sessions and a management executive is usually also present. Interviewed advisory board members believe that working in the board is useful, although results can often be seen only in the medium to long term. However, members also benefit by gaining insight into company structures. The interviewees experience MoBiel as a company that is honestly interested in connecting with its customers.

9.3.3 Citizens Exhibitions (Example: "Ready to Move …?!", Hyderabad 2009)

The Citizens Exhibition represents a new method of public participation, presenting the local people's views, together with pictures of them and their urban environment, in a public poster exhibition. This links actual discussion with participative elements and aesthetic components. The main objective is to present the attitudes, goals, and motivation of stakeholders—such as neighborhood residents, municipal administration, and private investors –to spur public dialogue and promote understanding around the particular issue. Moreover, it makes plans and future activities more transparent. The major strength of this approach is the emotional power of pictures combined with their corresponding personal statements (Dienel and Schophaus 2003).

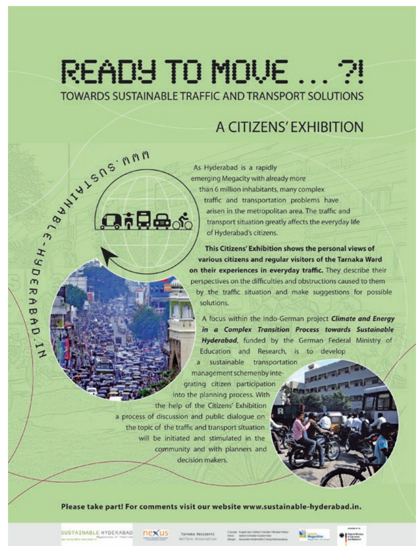


Fig. 62: Poster of Citizens Exhibition: "Ready to Move … ?!", Hyderabad 2009 (nexus)

The Citizens Exhibition method is comprised of the following stages: At first, an appropriate topic is selected—ideally a matter that every citizen can identify with. In Hyderabad, the exhibition illustrated city traffic and transportation, a topic every citizen can talk about. Second, 12 to 15 interview partners are identified. It is advisable to select interview partners with differing profiles in order to provide the broadest possible range of views and allow underrepresented perspectives a voice. Third, semi-structured qualitative interviews are conducted. For the Citizens' Exhibition "Ready to Move…?!" inhabitants and frequent visitors of the Tarnaka ward were interviewed, either on the street or in their home or office. To acquire a broad range of views, participants varied in gender, age, socio-economic background, and occupation (school children, elderly, businessmen, rickshaw drivers, street food vendors, housewives and representatives of the local administration). They were asked what transportation problems they faced and what kind of improvements they suggested (Jain et al. 2012). The interviews are recorded and transcribed verbatim. During or after the interview, pictures are taken of the interviewee and of different traffic situations to provide visuals of their personal situation. In the fourth step, the images and excerpts of interviews are creatively arranged for a public poster exhibition. This exhibition can be prepared on a very low budget, but the exhibits should always combine images and texts so that the views can be presented in layers of detail. The texts should be short, characteristic excerpts from the interviews. The final step, the opening of the exhibition at a local venue, plays a key role. All interviewees and participating interest groups are invited, along with the interested public. In addition to its public impact, the opening provides an opportunity for initiating dialogue within and between the different interest groups. This can take place either informally, while looking at the posters, or in a structured form, like a moderated discussion.

9.3.4 Youth Participation in the MENA Region

Youth participation can be a strategic route for strengthening the role of civil society and deepening democracy. The Arab Spring uprisings are full of stories about creative and modern tools for mobilizing young people. Indeed, "new social media, such as Facebook, Twitter and blogs, have played a prominent role" in the democratic awakening of Yemen, Morocco, Syria, Jordan, Egypt, and Tunisia (DUF 2010, p. 8). Until now, the position of youth in these societies has been extremely weak, despite calls for the creation of more space and empowerment in the access and means of communication for both rural and urban youth. However, the rapidly increasing number of social forums and other means of digital mass communication "must translate into policy and social and political change" (Ibid). However, if virtual activism is not clearly linked to strategic action then its impact in the real world will remain limited. In order to achieve action, two approaches are recommended (Ibid., p. 19):

- Capacity and competence development to empower youth to participate actively and responsibly. Youth require knowledge, skills, and tools to become involved and play an active role in programs, communities, and societal reform processes. Competence development should help youth become informed citizens, committed to promoting development and inclusion among their peers and within their communities.
- Space and promotion of an enabling environment to sensitize communities in order to create space for youth participation. A substantial part of the programming must be directed at working with communities in order to create an enabling environment so that there is space for youth to participate.

9.4 Parameters for Participative Processes

When citizen participation is initiated by a municipality or any administrative body, information and preliminary consultations should take place at an early, informal stage of the planning process. In most cases it is advisable to have the process moderated by a neutral person or organization and to choose the participatory method carefully according to the following metrics:

Character of the topic	→ Need to mobilize creativity or to resolve conflicts?
Size of the issue	→ Complexity, number of stakeholders affected or involved?
Participants	→ Number? Selection? Level of expertise?
Timing	→ Sequence of tasks? Availability of information? Time for consideration?

10 Approaches for Assessing and Monitoring Neighborhood Sustainability

Leslie Quitzow

Assessing and monitoring urban sustainability is a challenging task that requires attention throughout the planning process and beyond. It is an essential element of strategic planning that can be used for urban analysis, policy design, the development of urban sustainability strategies, and for engaging residents in a dialogue about the future of their settlement. There are a number of internationally recognized ways to assess urban sustainability, a selection of which will be presented in the following chapter. Since there is no single way to assess and monitor urban development, this chapter is a compilation of ideas and recommendations rather than a concrete manual of instructions. Given the nature of this publication, special emphasis will be laid on the assessment of climate sensitivity and resource efficiency as opposed to overall quality of life or sustainability.

An ideal monitoring system facilitates the continuous adjustment and revision of the urban planning process and the steady improvement of its outcome. Ideally, a monitoring system will also influence policy-making towards sustainable development goals.

For a monitoring system to work, it must be established early on in the planning process, and regular assessments must be included as an integral part of the planning cycle. Dedicating time, staff, and budget to the implementation of a monitoring system is therefore essential for its success.

An urban monitoring system points out intended and unintended developments at an early stage, so that there is room for improvement, adjustment and change. By monitoring urban development processes, political and/or planning decisions can be specifically directed at certain pressing issues or intentions. Furthermore, urban planning tools and urban planning policies can be tested for their utility and success. Without a monitoring system, it becomes more difficult to trace progress back to a specific action or intervention. The process of establishing a monitoring system can also initiate citizen participation and—if properly managed—strengthen community commitment, as well as create a dialogue and foster working relationships between institutions, different levels of administration, and the public.

The specific content of a monitoring system depends very much on its purpose, its scope, and its target group. Who will make use of the assessment and what for? Is it aimed at the planning community? Is it supposed to inform political decision-makers? Or is it meant for the public, i.e. residents? Moreover, should the measurement describe a neighborhood, an urban area, or an entire city? This chapter focuses on how urban monitoring can guide planning and political decision-making at the neighborhood level; it is intended for the professional planning and decision-making community as well as interested neighborhood organizations.

It is worth noting that many community-driven monitoring initiatives have developed their own monitoring systems in the past, and have thus made a valuable contribution to international standards for measuring urban sustainability. "Sustainable Seattle" was one of the first community led indicator initiatives to monitor sustainable development in 1998. Its current (fourth) indicator process can be followed at: *www.b-sustainable.org*. The "Boston Indicators Project" is another long lasting community led indicator initiative and can be found at: *www.bostonindicators.org*. These community driven approaches are especially valuable in creating community ownership, giving monitoring the necessary importance and support, and involving all stakeholders in a dialogue. If the community is not already active, experience has shown that communication about goals and indicators can be a valuable entry point for a participatory process to develop strong linkages with and between residents (Holman 2009).

10.1 Goals, Targets, and Benchmarks for Monitoring and Assessment

City and neighborhood monitoring should follow agreed-upon development goals, and relate to specific long-term and short-term targets. UN-Habitat recommends city level monitoring of long-term targets on a 20 to 30 year basis and short-term progress once every year (UN-Habitat 2012b). One of the major difficulties linked to the definition of targets and measurement of progress is the necessity to accurately describe the status quo as the basis for reference. Gathering the necessary baseline data can be a real challenge, since city or neighborhood level data is often not readily available. While difficult, this obstacle bears the benefit of sparking awareness about data gaps and initiating a regular collection process.

Benchmarking enables cities to compare their progress with that of other cities. The rising awareness of climate change has triggered a wave of assessments and documentations of "green" success stories as cities compete for the lead in international comparisons. With increasing international competition, it has become more and more common to rank cities and neighborhoods according to their performance. However, it should be kept in mind that cities—and neighborhoods even more so—have unique characteristics that require unique planning responses. While city and neighborhood rankings may appeal to the broader public and provide a useful overall status review, they do not reflect unique characteristics with the depth necessary for a sensitive planning policy. In order to serve as a valuable policy and planning tool, a monitoring system should therefore focus on the specific qualities of the urban space under investigation, and be consistent in and of itself, rather than catering to the broader requirements of (inter)national comparability. Planners should rely on case-specific, specially tailored monitoring systems that directly reflect their city's or neighborhood's situation and address their specific needs. Nevertheless, neighborhood targets often coincide with larger scale government plans, for example national or city sustainability strategies or Local Agenda 21s. For practical data collection reasons, it can be helpful to regard the monitoring system as part of a broader assessment logic, so that certain indicators overlap across the different scales.

10.2 Neighborhood Certification Systems

Rather than informing long-term policy decisions, neighborhood certification systems were developed to create an incentive for private developers to incorporate principles of sustainability into their projects. Neighborhood certification systems are standardized tools designed to evaluate community development projects from the planning stage—including planning documents and procedures—to their outcome and development over time. Inspired by the success of certificates for "green" or sustainable building, they rank the sustainability of communities within a national setting according to a system of checklists and points. While monitoring systems are typically designed to observe an already existing area, neighborhood certification systems assess planned developments even before they are built.

The American "LEED-ND" (Leadership in Energy and Environmental Design for Neighborhood Development) and the British "BREEAM Communities" (Building Research Establishment Environmental Assessment Method for Communities) are leading examples of country-specific neighborhood certification systems that measure the level of attainment of certain sustainability criteria on the basis of universally defined standards. Launched in 2009, both LEED-ND and BREEAM Communities emerged from existing systems for building certification. Their certification logic provides a good insight into what neighborhood sustainability

Urban Form

Possible indicators for monitoring resource-efficient and climate-sensitive urban form:

- Floor area ratio;
- Mix of uses;
- Public space and parks per capita;
- Pedestrian and bicycle space per capita;
- Public transport use.

Urban Resources

Possible indicators for monitoring urban resource efficiency:

- Amount of water consumed;
- Amount of wastewater reused;
- Amount of energy produced;
- Amount of energy from renewable sources;
- Amount of waste recycled.

Urban Technology

Possible indicators for monitoring the use of technology for sustainable urban development:

- Length of public transport network;
- Number of solar panels sold;
- Amount of waste recycled;
- Amount of wastewater reused.

Urban Governance

Possible indicators for monitoring urban governance:

- Existence of strategic planning documents;
- Sustainable development action plans;
- Institutionalized citizen participation;
- Cross-sector cooperation;
- Transparency of decisions,
- Percentage of budget spent on infrastructure.

means for the US and the UK, and can therefore serve as valuable guide for local authorities elsewhere.

Community certification systems are highly controversial among urban planners because they can become an excessively powerful market instrument with the potential to exacerbate neighborhood differences by influencing the flow of private investments. Neighborhood certification systems capture the level of sustainability of a given plan or settlement by the standards of a nation-wide norm. By ranking different settlements in this way, they create an incentive for private developers to stick to the agreed norm, and thus encourage sustainable building and planning practices. They do not, however, provide case-specific, policy-oriented information for planners or decision-makers, nor do they encourage civic engagement in the monitoring process.

Many countries are currently in the process of developing their own neighborhood certification systems based on the above-mentioned models. In the MENA region, the most prominent examples are the Green Pyramid Rating System from Egypt and the Pearl Community Rating System from Abu Dhabi. The Green Pyramid Rating System for buildings is in the final stages of development, and is supposed to be extended to cover sustainable communities in the near future (Farouh 2012). It is being developed by the Egyptian Green Building Council in cooperation with the Housing and Building Research Center, Cairo. The Pearl Community Rating System was developed by the Abu Dhabi Planning Council and assesses the sustainability of planned urban development projects throughout their life cycle. It is designed for communities of more than 1,000 inhabitants and especially tailored to the conditions of the Middle East.

10.3 What to Assess and Monitor in a Neighborhood

An ideal neighborhood assessment captures every relevant aspect of the given situation and dynamics, as well as of the obstacles and available development potentials of a specific urban location. First and foremost, this requires a clear understanding of the desired development objectives. The classification of urban sustainability into relevant sub-goals is the first step towards a local understanding of sustainable development. Though the present publication focuses on the environmental dimension of sustainability, the following section will make frequent reference to overall sustainability, as we consider it the ultimate goal and guiding principle of urban development.

Though the choice of categories (or goals) to represent urban sustainability varies with every monitoring system, there is a certain core set of principles that is reflected in most variations. These are: economic efficiency, social well-being, and environmental protection. Often "good governance" is listed as a separate category; otherwise it is included in the social section. For example, the European Reference Framework for Sustainable Cities, an online toolkit for local authorities working towards integrated sustainable urban development, includes "governance" as a separate category in its indicator library (*www.rfsc.eu*). A further example is the Global City Indicators Facility, a web-based tool launched by the government of Japan and the World Bank in 2012 that enables cities to measure, report and compare their performance with other cities around the world. This tool makes a simpler division by describing only the two main categories "city services" and "quality of life" and structuring them around 18 themes (*www.cityindicators.org*).

On the urban scale, it is advisable to divide these general categories of sustainability into more specific target-based themes or areas of intervention, as done by the Asian Development Bank, for example, which distinguishes eight goals that are represented by twelve areas of intervention (see Tab. 3).

Each area of intervention is assessed with between eight and 16 separate indicators in order to give a picture of sustainable development in the cities of Asia's developing countries. Many of these categories overlap and influence each other.

10.3.1 Including Resource Efficiency and Climate sensitivity in an Assessment

In the light of the ongoing debate about cities and climate change, resource efficiency and climate sensitivity have gained ground in city and neighborhood assessments. The spectrum of criteria to separately assess urban environmental performance is diverse and must be carefully chosen to adequately reflect each specific urban situation. The research described in the previous chapters has shown that the following categories are fundamental for obtaining resource-efficient and climate-sensitive urban fabric, and are therefore key to any relevant assessment (see Tab. 4).

Goals	Areas of Intervention
·· Alleviation of urban poverty, ·· Improved quality and quantity of social infrastructure, ·· Urban productivity and competition, ·· Urban land and housing, ·· Urban services (water, electricity, sanitation, and solid waste management), ·· Environment, ·· Urban transport, ·· Urban governance and management.	·· Population, ·· Equity, ·· Health and education, ·· Urban productivity, ·· New technology, ·· Urban land, ·· Housing, ·· Municipal services, ·· Urban environment, ·· Urban transport, ·· Local government, ·· Urban governance.

Tab. 3: Categories of sustainable urban development as devised by the Asian Development Bank (Westfall and De Villa 2001)

Effective water supply under conditions of scarcity plays a crucial role in the MENA region and must therefore be given special attention in any assessment in this area. Moreover, assessing the climatic conditions of the settlement under investigation is paramount to the development of locally adapted environmental goals.

10.3.2 Selecting Appropriate Indicators

Indicators concentrate the highest possible amount of relevant information about a neighborhood in the smallest possible amount of facts. Typical questions that indicators must be able to answer are: Where does our neighborhood stand today? What are the recognizable development trends? Are we getting closer to reaching our targets? The total number of indicators should be kept to a reasonable limit in order to keep the amount of information manageable.

Two basic types of useful indicators can be distinguished for a neighborhood assessment: delivery indicators that measure the administration's input, and state or impact indicators, which describe where the neighborhood stands. The following examples show delivery and impact indicators for resource efficiency and climate sensitivity in a city (see Tab. 5).

Area of Intervention	Goal
Urban form	•• Compact urban structure •• Functional mix •• Population density
Architecture	•• Culturally adapted architecture •• Energy-relevant quality of buildings
Green and open spaces	•• Locally adapted vegetation •• Spaces for recreation
Mobility	•• Internal connectivity •• Slow means of transport (i.e. walking or cycling) •• Public transport
Energy management	•• Low carbon energy management •• Renewable energy sources
Water supply and wastewater management	•• Efficient water cycles •• Re-use of gray water
Solid waste management	•• Efficient waste cycles
Governance	•• Strategic planning processes •• Regular monitoring
Public awareness and capacity building	•• Environmentally conscious behavior •• Sufficient capacities for energy-efficient construction

Tab. 4: Categories of resource-efficient, climate-sensitive urban development as devised by the Young Cities project

In order to fully represent climate sensitivity and resource efficiency goals, state or impact indicators should also describe the local climate, including innovative approaches such as "solar potential". Indicators should be measured on a regular basis and compared over time in order to identify development trends. Moreover, it is also advisable to include qualitative indicators in an assessment, for example "citizen satisfaction with green and open spaces in their neighborhood", or "perception of climate change among youth". UN-Habitat's State of Arab Cities Report, for example, lists source countries of migrant workers in the GCC countries as a qualitative indication of remittance flows (UN-Habitat 2012v). Though qualitative indicators are generally more expensive to assess, they can give valuable impressions of residents' opinions, fears, hardships, and aspirations and thus help embed the quantitative information in a more human narrative.

10.3.3 Balancing the Trade-Offs of Indicator Design

An ideal indicator should be sensitive, measurable, achievable, relevant, and time-bound, also known as S-M-A-R-T.

Sensitive Indicators should be sensitive to desired and undesired developments, signaling change when change occurs—neither too early nor too late.

Measurable The availability of data should guide the choice and development of indicators. Without accessible data, indicators remain hypothetical and cannot inform action.

Achievable The targets linked to an indicator should be achievable within a reasonable time limit, otherwise progress will be slow and work demotivating. However, short-term targets should be inspired by long-term visions.

Relevant An indicator should provide information that is relevant to its underlying objective and to the formulation of policies or planning interventions. It should measure circumstances that can be influenced by planning actors.

Time-bound Indicators should be assessed on a regular basis, and should be linked to targets that are within reach.

Delivery Indicators	State/Impact Indicators
•• Budget allocated to subsidies for retrofitting privately owned buildings with renewable energy sources. •• Km of light passenger transit system per 100,000 inhabitants •• Percentage of water loss •• Existence of city or neighborhood sustainability action plans	•• Residential energy use per household by type of energy •• Annual number of public transit trips per capita •• Quality of air and water •• Citizen satisfaction with municipal service delivery

Tab. 5: Sample indicators

Ideally indicators should combine all of the above characteristics in order to fulfill their purpose, which naturally involves a number of trade-offs. The availability of data can be an especially serious obstacle to indicator development.

10.3.4 Whom to Involve in the Choice of Indicators

The more intricate one's knowledge of a location, the better and more sensitive the potential monitoring system will be. Participation in indicator design not only creates a sense of ownership, but is also a key part of producing a relevant information base. For this reason, incorporating citizens' understanding of their area into the development of a monitoring system can greatly increase its utility. The indicators for the Global Urban Indicators Facility, for example, were selected and developed by the cities themselves.

10.3.5 The Special Case of Urban Indexes

Indexes are valuable tools for effectively communicating certain topics to a wide and diverse audience, because they condense complex information into easily understandable messages. Highly aggregated single indexes are easy to communicate, such as the Siemens "Green City Index" that measures the overall environmental performance of cities, or UN-Habitat's "City Prosperity Index" that is a combined measurement of city productivity, quality of life, infrastructure development, environmental sustainability, and social inclusion (Siemens 2012, UN-Habitat 2012d). However, due to their high level of aggregation, indexes are not a sufficient basis for well-informed political decision-making or planning at the neighborhood level.

The Siemens Green City Index was developed in 2009 and highlights critical aspects of urban environmental sustainability—namely CO_2 emissions, energy, buildings, land use, transport, water and sanitation, waste management, air quality, and environmental governance—and compares them for cities on five continents. The composition and methodology of the index was wisely adapted to the specific environmental challenges of each world region, creating five separate indexes for the benefit of informational quality but at the cost of global comparability. By contrast, UN-Habitat's "City Prosperity Index" that was launched at the 2012 World Urban Forum holds on to the notion of global comparability by way of ranking cities globally according to overall achievement in the five above-mentioned sectors.

While indexes serve as useful regional or global comparisons, indicator frameworks are more detailed and therefore are a more appropriate basis for the development of specific local policies or neighborhood interventions. Lists of indicators more accurately reflect specific urban planning challenges, are more sensitive to developments and changes, and can more easily spark a policy or planning reaction.

10.4 How to Integrate Monitoring and Evaluation into the Planning Process

An urban monitoring system should be able to concisely describe an urban situation and to perceive relevant changes and developments in order to quickly and effectively trigger the correct interventions. It should be conceived by the institution or group of people responsible for carrying out the task of monitoring. A monitoring system is always closely related to the goals and values attached to the development process and should therefore be established as early as possible, preferably alongside the definition of the planning goals. The system should always be explicit about and, of course, sensitive to the intentions it pursues. It is important to understand that indicators always implicitly or explicitly reflect an underlying value system and will therefore never be entirely objective.

In its Global Report on Human Settlements 2009 UN-Habitat recommends the following order of activities:

1. Formulate goals and outcomes
2. Select indicators
3. Gather baseline information
4. Set specific targets to reach and dates
5. Regularly collect data to determine progress
6. Analyze and report results

This order should be repeated in a cycle, so that the analysis of results is followed by the reformulation of goals and outcomes in a continual, iterative process. Monitoring can be carried out by the planning institution itself (public administration or planning office) as well as by external specialists. Community-driven monitoring initiatives constitute a third possibility, namely monitoring by the end-user. If community-driven initiatives are already in action, they should be incorporated into indicator design and monitoring in order to create ownership, increase communication between administration and residents, and enhance the planning perspective.

10.5 The Data Challenge

The most serious challenge to any indicator initiative at the neighborhood level is the scarcity of data.

> ***A set of highly relevant indicators and an intricately designed monitoring system are worth little if there is no data.***

Data can either be acquired through first-hand collection or by relying on existing statistical material, such as censuses. Institutions that regularly collect data and are often willing to make it available for monitoring purposes include national statistical offices, ministerial and municipal administrations, universities, independent research institutes, non-governmental organizations, military institutions, municipal service companies, private service companies, and other private companies.

Because first-hand data collection is usually very expensive, indicators should always be chosen with the question of data availability in mind. Almost always, there is a trade-off between finding the most relevant indicator and being able to supply sound data for its appraisal. The data issue is crucial to the entire validity of the indicator framework.

10.6 Further Online Sources of Information on Urban Indicators

Global indicator initiatives

Global City Indicators Facility (Worldbank):
http://www.cityindicators.org/

Global Urban Observatory (UN-Habitat):
http://ww2.unhabitat.org/programmes/guo/

Siemens Green City Index:
http://www.siemens.com/entry/cc/en/greencityindex.htm

Regional indicator initiatives

Urban Indicators for Managing Cities (Asian Development Bank):
http://www.adb.org/publications/urban-indicators-managing-cities

European Reference Framework for Sustainable Cities
(European Commission): http://www.rfsc.eu/

Local indicator initiatives

Sustainable Seattle (USA):
http://www.b-sustainable.org

Boston Indicator Initiative (USA):
http://www.bostonindicators.org

Neighborhood certification systems

LEED-ND (USA):
http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148

BREEAM Communities (UK):
http://www.breeam.org/page.jsp?id=372

Green Pyramid Rating System for Buildings (Egypt):
http://www.egypt-gbc.gov.eg/ratings/index.html

Pearl Community Rating System for Estidama (Abu Dhabi):
http://www.estidama.org.

V

Profile, Climate Change, and Urbanization Challenges in Iran and the Tehran Region

This chapter frames the context of the Young Cities as a project in the vicinity of Tehran, Iran. It describes Iran's: urbanization processes; demographic, social, and economic conditions; aspects of energy consumption; availability and usage of natural resources; and land use as well as Iran's national regulations for saving energy. Finally, the city of Tehran is profiled, followed by a description of the specific urban challenges Iran and Tehran face.

1 Profile of Iran

Mahta Mirmoghtadaee

Fig. 63: Provinces of Iran

1.1 Historical and Geographical Context

Iran is one of the oldest countries in the world, home to a civilization with ancient roots. The Achaemenid (550–330 BC), the original Iranian empire, was once the largest empire in the world. Its population outnumbered any other, and it "extended from the shores of Turkey and Egypt in the west through the Levant to Mesopotamia into Iran, Central Asia and part of north-west India" (Kuhrt 2007). The advent of Islam was a turning point in the country, introducing not just a new religion, but also new social and legal systems. After the Islamic revolution in 1979, Iran officially became an Islamic republic.

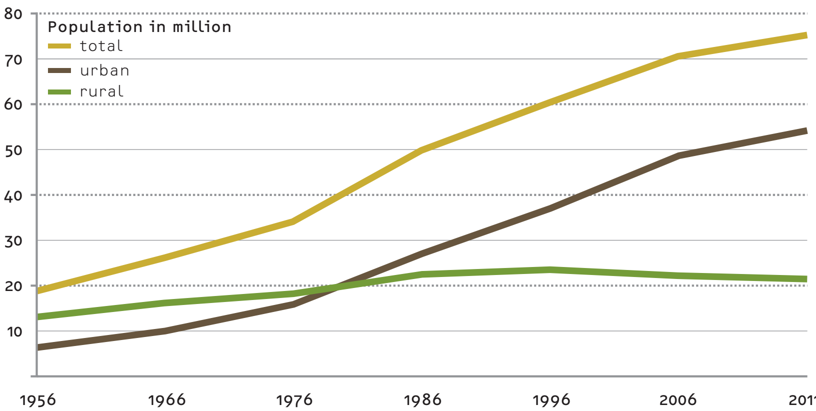
Iran is bordered by Iraq and Turkey to the west; by Armenia, Azerbaijan, Russia, and Turkmenistan to the north; and by Afghanistan and Pakistan to the east. Iran's southern border is a coastline of 2,440 km on the Persian Gulf and the Sea of Oman. A part of Iran's northern border is also coast, with 740 km along the Caspian Sea (Sabetghadam 2006).

Iran has a great geographic variety, from the Kavir desert to the Zagros mountains in western Iran or the Alborz mountain range with the 5,671 meter Damavand peak. It also is a country of extensive ethnic and linguistic diversity. The main ethnic groups include: Persian, Azari, Kurd, Lur, Baloch, Arab, Turkmen, and Turkic tribes. Iran's official religion, Islam, is followed by 99.4% of the population. Other religions, with a share of less than 1%, include Zoroastrianism, Judaism, and Christianity (Statistic Center of Iran 2011).

1.2 Demographic Development and Socio-Economic Context

According to the 2011 Iranian National Census, more than 75 Million people live within Iranian borders. After decades of rapid expansion, with population doubling in the last 35 years, population growth has recently slowed. From 2006 to 2011 the population growth rate was 1.29%, a decrease of 0.33% compared to the period between 1996 and 2006 (Statistical Center of Iran 2011). Nevertheless, the country's population is still growing, and in 2050, Iran will be home to 100 million people. The projected median age for this population is 40, twice the current average; a significant and challenging circumstance. Improved health policies and a decreasing fertility rate will result in an aging population, posing a major challenge to Iran's health system and infrastructures (UN 2007). However, the recent national census (2011) shows a slight increase in the 0–4 age group, which might indicate a new wave of population growth.

Another major demographic trend is decreasing household size, which goes hand in hand with the increasing number of households (Statistical Center of Iran 2011). This demographic trend is the result of a socio-economic transition: the tertiarization of Iran's economy starting in 20th century and the increasing individualization of Iranian society (EBO 2013). Combined with the declining fertility rate, these drastic shifts will affect patterns of resource use and mark the dawning of a challenging new era for Iran.



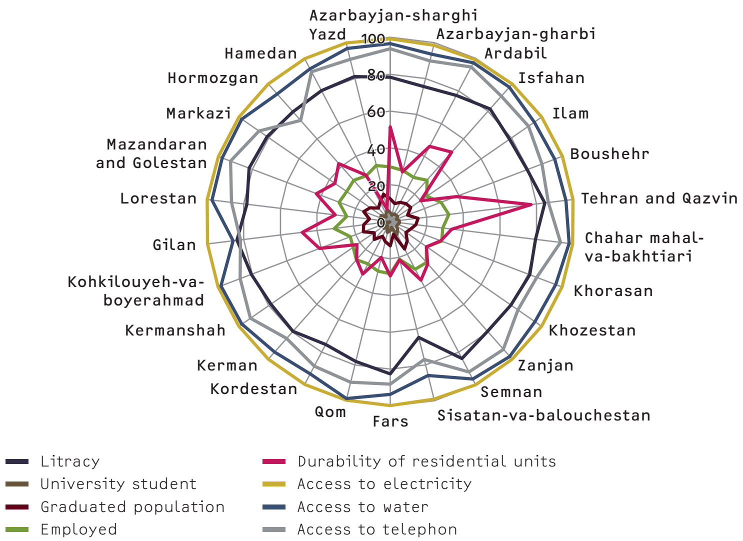


Fig. 64: Population growth in Iran (based on data from Statistical Center of Iran 2006/11) | Fig. 65: Development indexes for Iranian provinces in 2006 (based on data from Statistical Center of Iran 2006).

Iran's social and economic development in the last decades has been positive—the country's human development index has steadily increased, placing Iran above the regional average (HDR 2011). However, there are large regional inequalities in Iran; while there is a concentration of economic activities in the metropolitan areas, e.g. in Tehran, the infrastructure is poor in some rural areas. This is illustrated by the levels of urban and rural development in the provinces (Ziari et al. 2010 and Statistical Center of Iran 2006).

1.3 Urbanization

During the 20th century Iran gradually changed from a country dominated by a rural-nomad population to a largely urbanized one. A 1962 reform of agricultural land began Iran's gradual transition from an agriculture-based to an oil-based economy, as well as the acceleration of rural to urban migration (UNDP and DoE 2010). Urbanization continued to increase at a rapid pace even after the Islamic revolution. Today 71% of the population is urban and urbanization continues to grow: from 2006 to 2011, the average annual population growth rate in urban areas was 2.14%, while rural populations shrank by an average rate of -0.63% (Statistical Center of Iran 2011). As of 2011, there are 1,143 cities ("Shahr") and approximately 96,549 villages ("Deh" or "Roosta") in Iran (Statistical center or Iran 2011). Three main factors underlie urban expansion in Iran: the natural growth of population, the rural-urban migration motivated

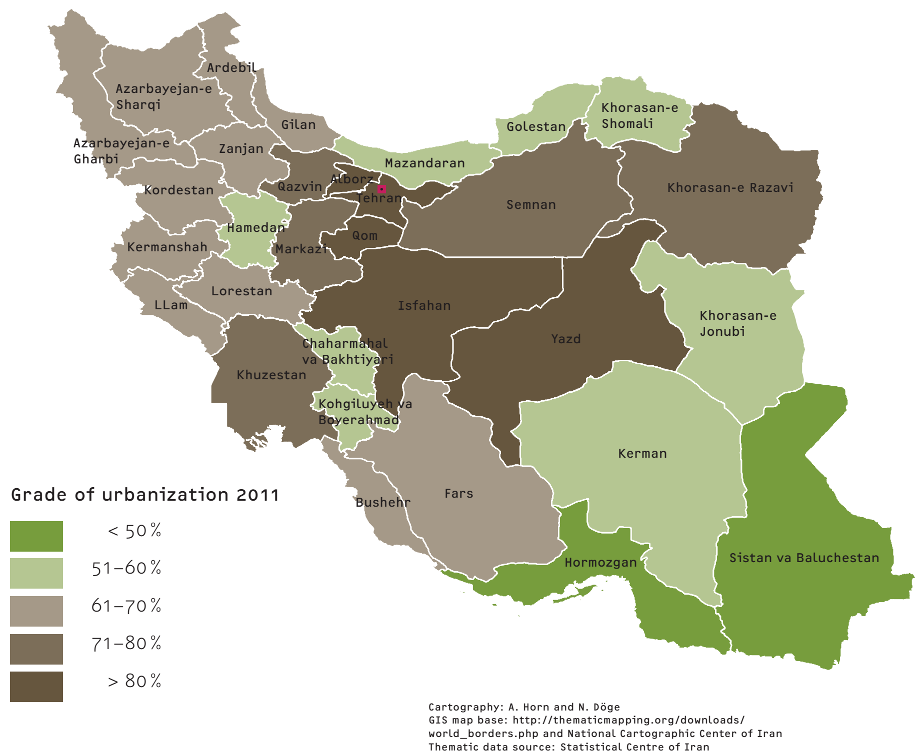


Fig. 66: Grade of urbanization 2011

by the superior socio-economic circumstances of cities, and changes to the official definition of rural areas which led to some former villages becoming cities due to their population growth. Though urban-rural differences are an important factor in migration from rural areas to big cities, statistics show that the majority of migration currently happens between urban areas. From 1996 to 2006, 30% of migration was of rural origins, the rest was from one city to another (Statistical Center of Iran 2006). Tehran Province has been the primary destination, absorbing 30% of the country's migration. Isfahan and Khorasan-razvi have the second position with about 5%.

It is very important to note that urbanization processes differ between the regions; Qom and Tehran have the highest urbanization rate, more than 90%, while Golestan or Hormozgan have an urbanization rate of only about 50%. This illustrates the inequality in the development levels of rural and urban areas in Iran, with lower urbanization leveld usually coinciding with lower development levels (Ibid.).

The residential sector has the highest energy consumption in Iran, followed by transportation and industry. Iranian households use natural gas and oil mainly for heating, cooking, and hot water. Lighting and appliances (including cooling systems) are the major components of household electricity use (IEA-WI 2009). There is a considerable amount of energy waste in the residential sector due to inefficient building construction and energy intensive household appliances (Farahmandpour et al. 2008).

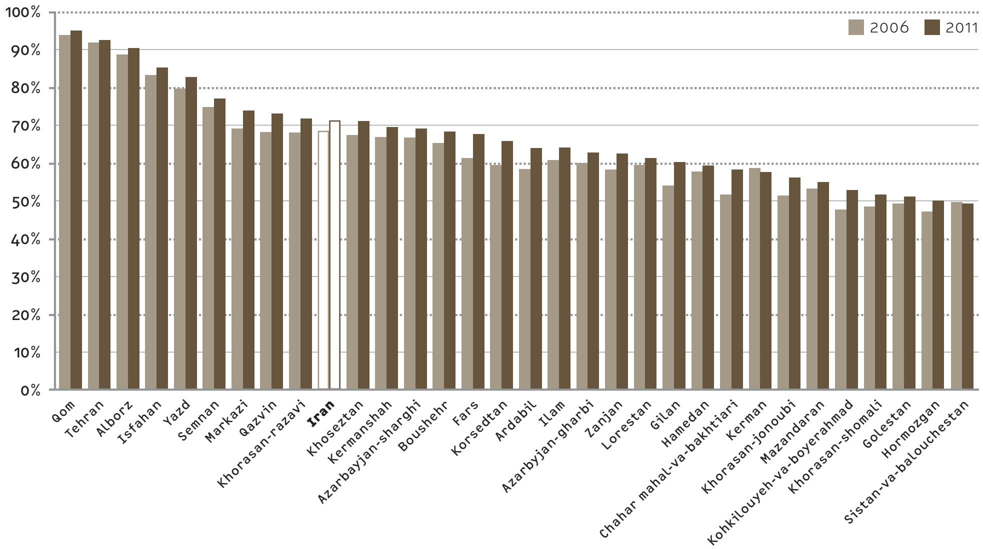
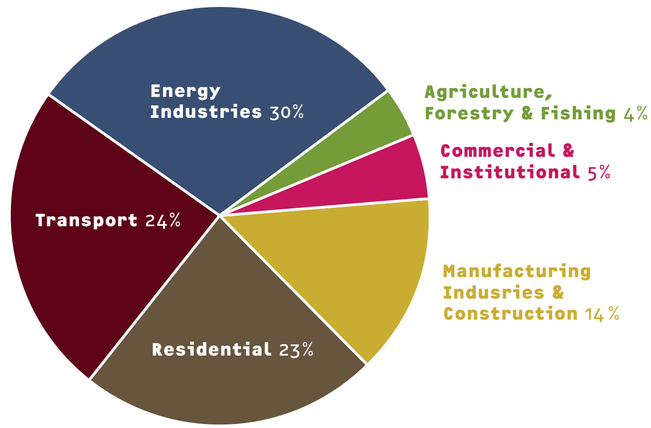


Fig. 67: Urbanization levels in Iranian provinces (based on data from Statistical Center of Iran 2011).



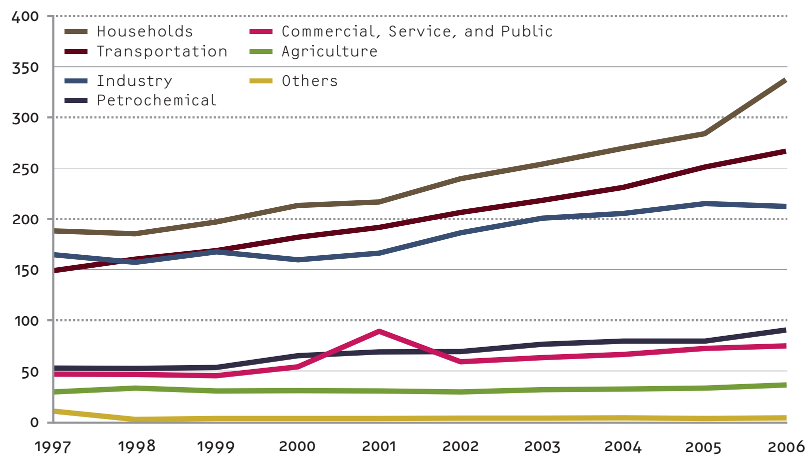


Fig. 68: Share of CO_2 emissions by sector in 2000 (based on data from UNDP and DoE 2010) | Fig. 69: Final energy consumption by sector (based on data from Iranian Fuel Conservation Company 2009)

1.4 Energy Resources, Energy Consumption, and CO_2 Emissions

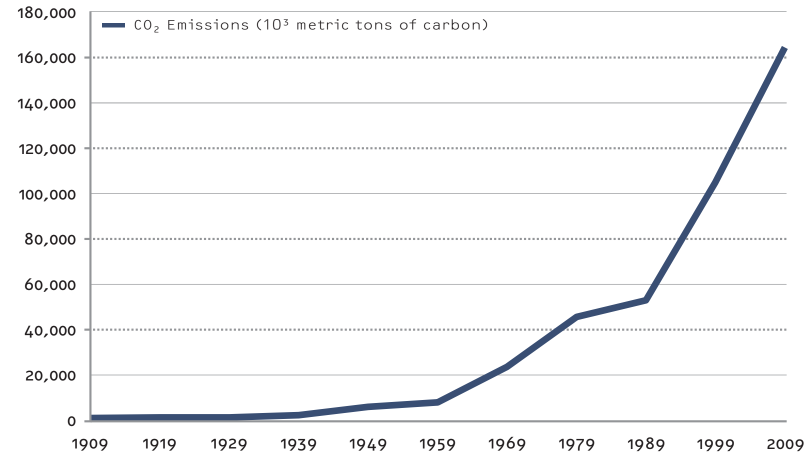
Iran has some of the largest oil and natural gas resources in the world. Not surprisingly, oil, petroleum products, and natural gas are the main energy sources in Iran (MoE 2009). Although the country also has great potential for renewable energies, e.g. solar photovoltaics (see I 7), the current primary renewable energy supply is negligible. This leaves ample room for improvement in related technologies and policy instruments.

As the sector with the greatest share of energy consumption, it is crucial to develop policies, strategies and measures for increasing the efficiency of Iranian residential energy use.

The use of natural gas for primary energy supply increased from around 20% in 1990 to over 50% in 2009. While the decrease in use of oil and petroleum creates comparatively lower amounts of CO_2 emissions, use of natural gas still accounts for a considerable amount of CO_2 emissions (MoE 2006).

Iranian energy industries are responsible for 30%, the highest share, of Iran's CO_2 emissions, followed by the transportation sector with 24%, with the residential sector close behind at 23% (UNDP and DoE 2010).

The transport sector's large, and increasing, share of CO_2 emissions is primarily due to the dominant and growing role of private cars in combination with inadequate public transport.



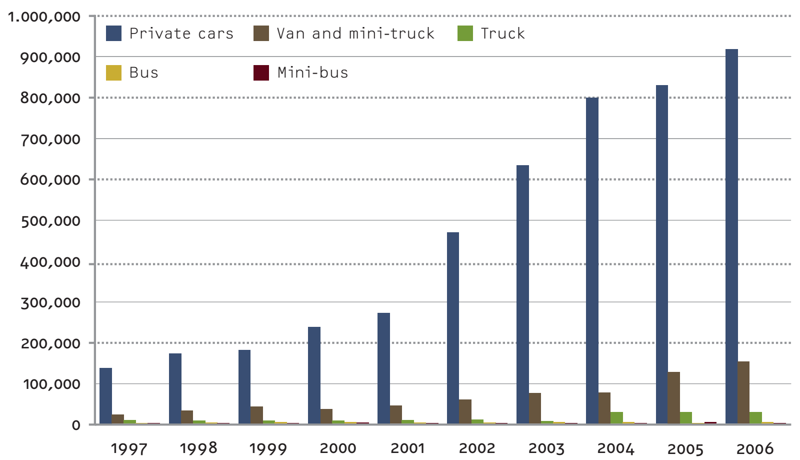


Fig. 70: Total fossil fuel emissions in Iran (based on data from Carbon Dioxide Information Analysis Center 2012) | Fig. 71: Registered vehicles in Iran (based on data from Iranian Fuel Conservation Company 2009)

1.5 Climate Conditions and Trends

According to the Köppen climatic classification there are three prevailing climate zones in Iran:

- the dominant climate type is arid and semi-arid climate (type B), covering 81% of the country,
- 17% of the country is of temperate or mesothermal climate (type C) and
- 2% of the country is of continental-microclimate (type D) (UNDP and DoE 2010).

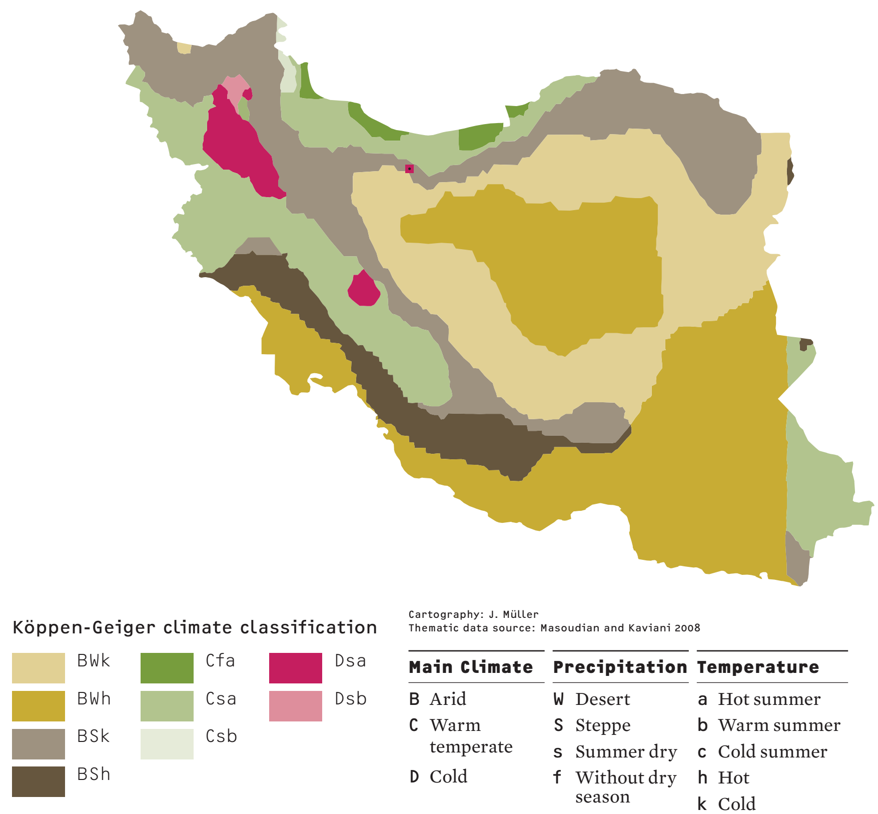
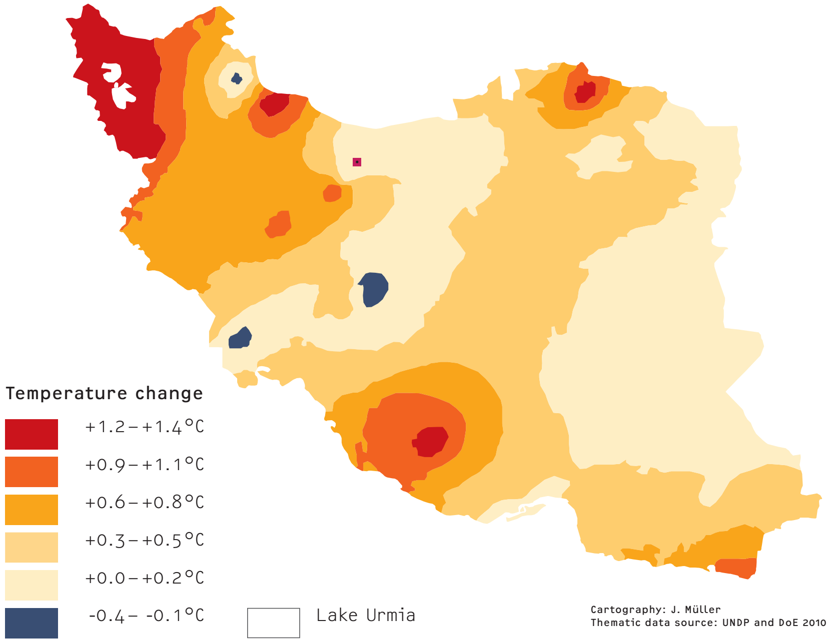
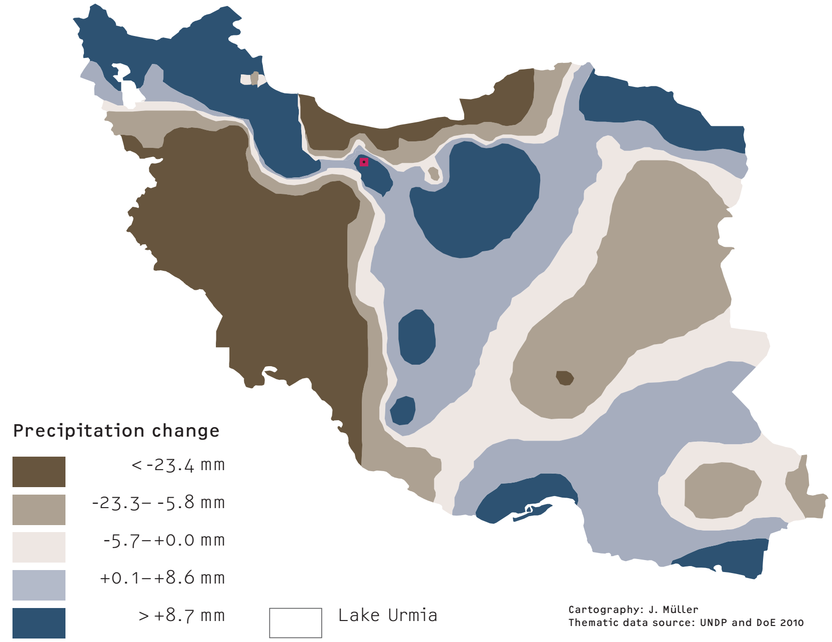


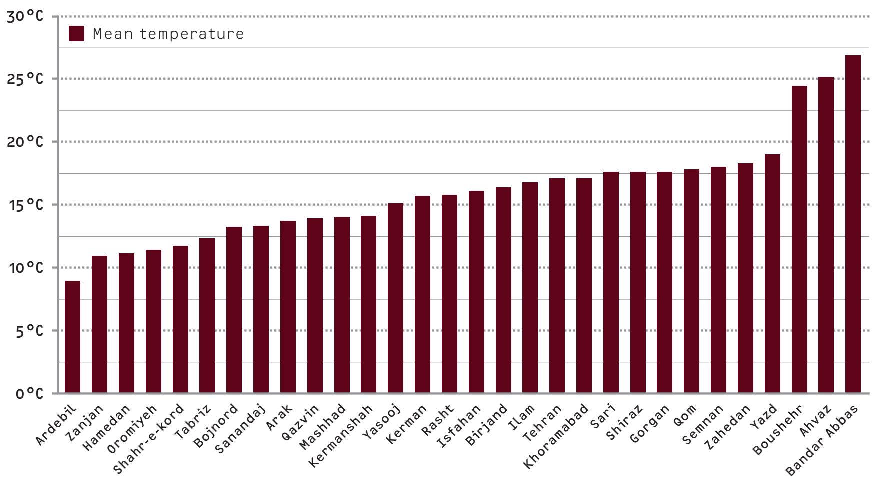
Fig. 72: Climate classification map of Iran (based on Masoudian and Kaviani 2008)

Iran's large fossil resources and increasing consumption thereof has put Iran in seventh place among the world's top CO_2 emitting countries. Emissions increased rapidly in the 1960s, slowed slightly during the eight year war period with Iraq, and have climbed steadily since the 1990s (Carbon Dioxide Information Analysis Center 2012).

In most Iranian cities the coldest month is January (with a monthly average temperature between -6°C and 21°C) and the warmest is July with a monthly average temperature between 19°C and 39°C. In most regions the highest precipitation occurs in winter and there is almost no rain in summer. However, it is very important to note that there are considerable regional differences in precipitation, with the average annual total ranging from 2,000 mm along the Caspian Sea to some areas in the cen-







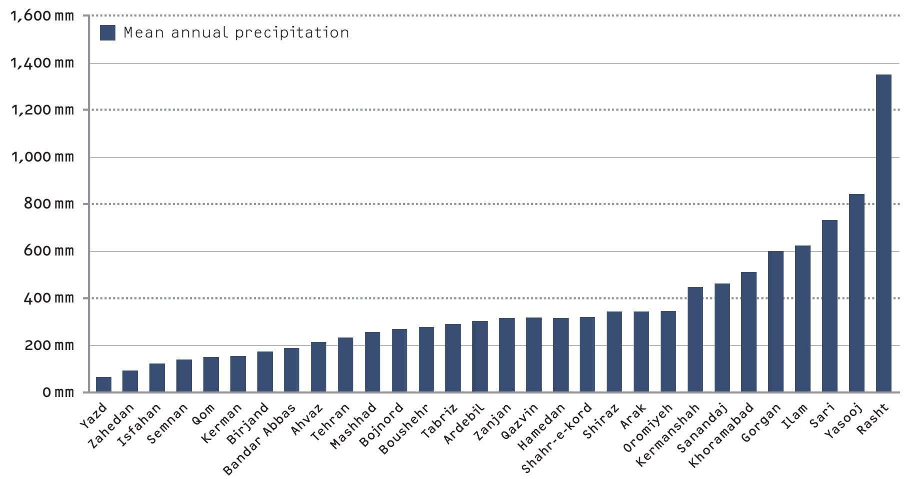


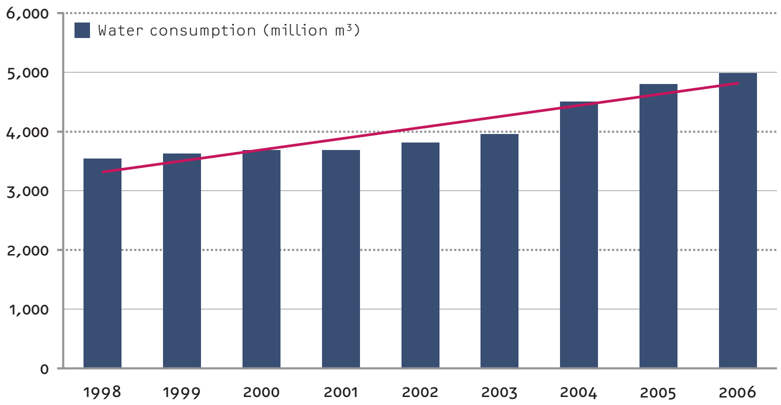
Fig. 73: Temperature change projections for 2010–39 with respect to 1976–2005 by LARS-Weather Generator | Fig. 75: Temperature of province capitals from the establishment of synoptic stations in 1951–87 through 2003 (Statistical Yearbook 2010)

Fig. 74: Projected changes in precipitation for 2010–39 with respect to 1976–2005 by LARS-Weather Generator | Fig. 76: Precipitation of province capitals from the establishment of synoptic stations in 1951–87 through 2003 (Statistical Yearbook 2010)

tral desert with almost no rainfall (UNDP and DoE 2010). In the coming decades Iran will feel severe effects of climate change. The following changes are projected for the period between now and 2039 (UNDP and DoE 2010):

- Temperatures will increase an average of 0.9°C. Minimum and maximum temperatures will rise by up to 0.5°C. Most parts of Iran will see more hot days and fewer freezing days. The increase in hot days will be more apparent in the southeast of the country, where the annual number of hot days will rise up to 44. The decrease in freezing days (below 0°C) will be more apparent in northwest, where freezing days will decline to as low as 23 annually. The increasing number of hot days will raise the demand for cooling, resulting in increased energy use and, thus, higher CO_2 emissions.

- Overall precipitation will decrease by an average of 9%, but the number of days with heavy rain will increase by 13% and the number of days with torrential rain will increase by 39%. This phenomenon will greatly increase flood risk. In the northwest, center, south, east, and southeast of Iran, there will be more wet days.
- However, other parts of the country will experience an increasing number of dry days, especially in cold seasons. This will intensify air pollution, especially in metropolitan areas where rainfall helps to remove ambient pollutant particles.



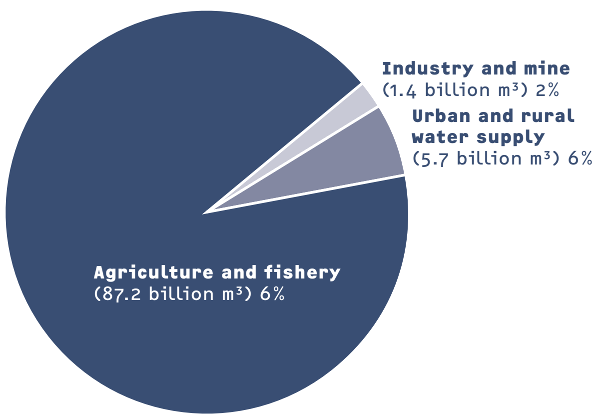


Fig. 77: Amount of urban water supply in Iran between 1998 and 2006 (own illustration based on inter 3 and NWWEC) | Fig. 78: Share of water use by sector in 2005 (own illustration based on UNDP and DoE 2010)

1.6 Water Resources and Consumption

Although it has a long history of agriculture, Iran is considered to be a dry country. Only some western parts and the coastal areas by the Caspian Sea receive adequate rainfall; there is a considerable shortage of water in the central plateau. Water resources shaped the historical settlement patterns of the country - permanent settlements were mostly developed in areas where rainfall permitted agriculture (Fisher 1968). Even today, agriculture and fisheries consume more than 90% of Iran's freshwater, while urban and rural water supply takes only 6%. However, with the changes in demographic development and urbanization processes, urban water consumption is steadily increasing (see Fig. 77). At the same time, recent and frequent droughts have negatively affected Iran's water resources. It is predicted that average renewable water resources will decrease from 1,900 m³ per capita in 2009 to 1,300 by 2021 (UNDP and DoE 2010).

1.7 Land Use, Ecoregions, and Biodiversity

According to Iran's "Fourth National Report to the Convention on Biological Diversity" (DoE 2010), the country's four main land categories are rangelands, deserts, cultivable lands, and forests. Rangelands have the greatest share with 52%, followed by deserts (20%), cultivable lands (11%) and forests (9%). Less than half of the cultivated land is irrigated, with more than half receiving adequate precipitation to support agriculture. The scarcity of cultivable land and forest highlights both the value of these natural resources and the need for their preservation. However, land speculation and residential development in forests, cultivable lands, and other ecologically significant areas (especially in northern Iran) has rapidly degraded this precious natural capital (Ibid.).

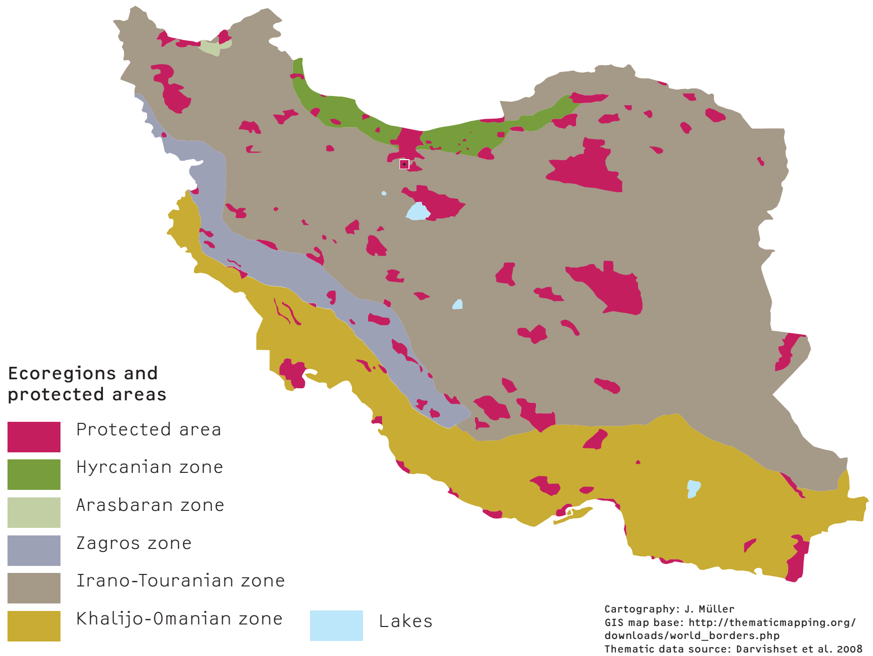


Fig. 79: Ecological regions and protected areas in Iran

Generally Iran can be divided into four eco-regions:

- Irano-Turanian,
- Hyrcanian,
- Zagros, and
- Khalijo-Omanian.

The Irano-Turanian region covers a large area in central Iran composed of both arid and semi-arid deserts. The Zagros region extends throughout the semi-arid Zagros Mountains to the west and south and parallels the Persian Gulf. The Hyrcanian region covers the semi-humid and humid Arasbaran and Hyrcanian mountains, extending across the Caspian plains and the northern part of the country bordering the Caspian Sea. The Khalijo-Omanian region encompasses the hot southern coastal plains with high humidity, extending throughout the south of the country in the Khuzestan, Boushehr, Hormozgan and Sistan- Baluchistan provinces (Ibid.).

1.8 Natural Hazards

A specific feature of Iran is its seismic position: Iran is located between the Arabian and Euro-Asian tectonic plates in a very active seismic region (IIEES 2010). Hence, most of the country is exposed to earthquake hazard. Large earthquakes, greater than 7 on the Richter scale, take place about every 10 years (Ebtekarnews 2012). Frequent seismic activity poses a significant threat to the country in both the number of victims claimed and the level of economic damage.

Another major hazard is flooding. According to the WHO flood risk index (see Fig. 81), the flood risk is higher in the northern (along the Caspian Sea) and western (along Zagros Mountain Chain) parts of Iran. However, only 5% of people killed by disasters were killed by floods during the last three decades, the other 95% of disaster deaths were due to earthquakes. In contrast, at 9%, floods affected a greater number of people. Earthquakes affected less than half that of floods, with 4%.

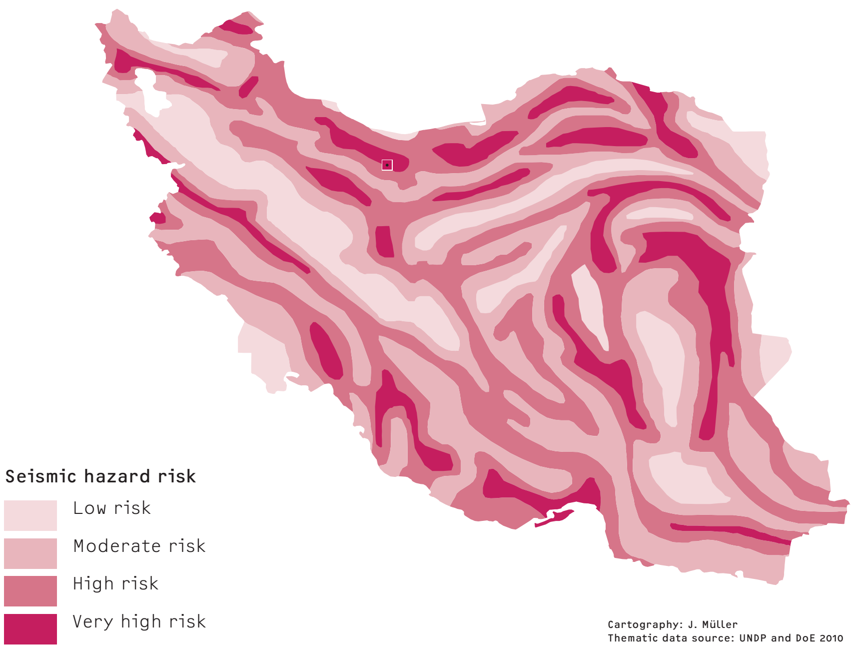


Fig. 80: Seismic hazard map of Iran

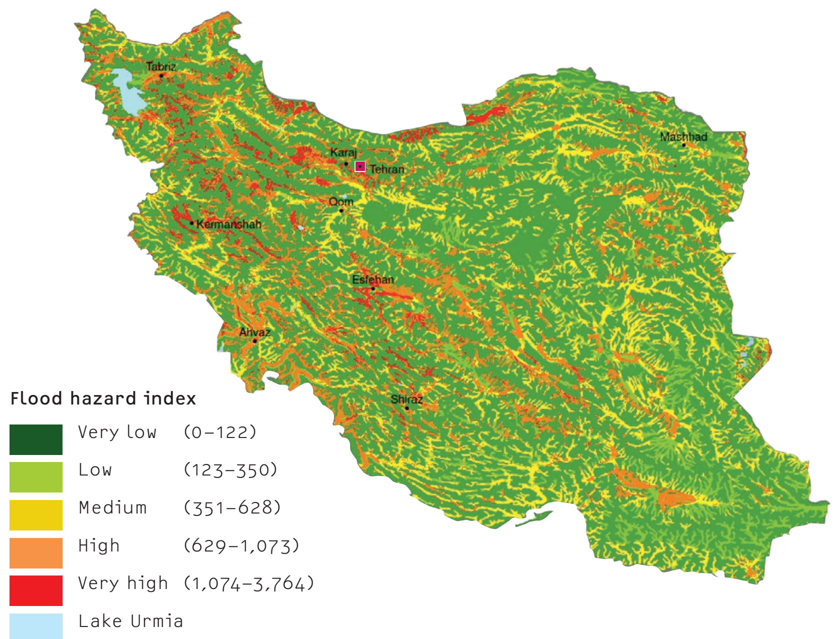


Fig. 81: Flood hazard map of Iran (adapted from WHO 2010)

Iran possesses diverse marine, coastal and wetland ecosystems. These unique environments need great attention and care from the people and government. However, due to population growth in both urban and rural areas, intensive use of natural resources, and destructive human activities Iran's biodiversity is threatened and has degraded. Climate factors such as prolonged and frequent droughts may add to this harm in the future.

Droughts were of the greatest impact, affecting the majority at 87% (UNISDR 2013).

Although droughts are often not fatal, they cause considerable economic damage. This will be even more of an issue in the future as floods and droughts become more frequently due to climate change.

1.9 Rules and Regulations relevant to saving Energy and Environmental Protection

The main legal instruments addressing energy efficiency and environmental protection with relevance for urban planning are the Air Pollution Prevention law, the Energy Consumption Reform Act, and No. 19 of the Iranian National Building Code: Energy Conservation in Building.

In the Air Pollution Prevention Law, it is articles 25 and 26 which are especially relevant. They focus on the scale of urban planning (TJA 2003):

Article No. 25 Air Pollution Prevention Law:
When preparing Guide Plans, Comprehensive Plans and Improvement Plans, the Ministry of Housing and Urban Development and the Ministry of Interior are each obliged to add a separate chapter of the study reports on environmental issues and problems, so that the design of cities, towns, and residential complexes, in regard to green and open spaces, juxtaposition of land uses, transportation networks, building densities, etc., will be compatible with environmental criteria approved by the Department of Environment.

Note: Plans for cities, residential areas, growth poles, towns, and industrial, administrative, and agricultural complexes should be provided according to rules and regulations of environmental protection.

Article No. 26 Air Pollution Prevention Law:
Executive regulation of article No.25 should be prepared jointly by the Ministry of Housing and Urban Development, the Ministry of Interior, and the Department of Environment and then approved by the cabinet.

The Iranian National Building Code No. 19 focuses on energy saving at the level of single buildings. The first Code 19 was compiled in 1991, but it was badly observed in practice, due to non-acquaintance of building specialists and controlling authorities as well as construction companies being unfamiliar with methods of insulating building components (Fayaz et al. 2009). In 2010 the third version of Code 19 was developed in an attempt to simplify the code as well as complete some of the technical chapters.

However, insufficient implementation and realization caused these legal instruments to be only partially effective. Meanwhile, there is ongoing research for another round of revision and improvement for Code 19, but there is little priority for developing energy efficiency mechanisms in urban planning and at the neighborhood scale.

2 Profile of Tehran

Mahta Mirmoghtadaee

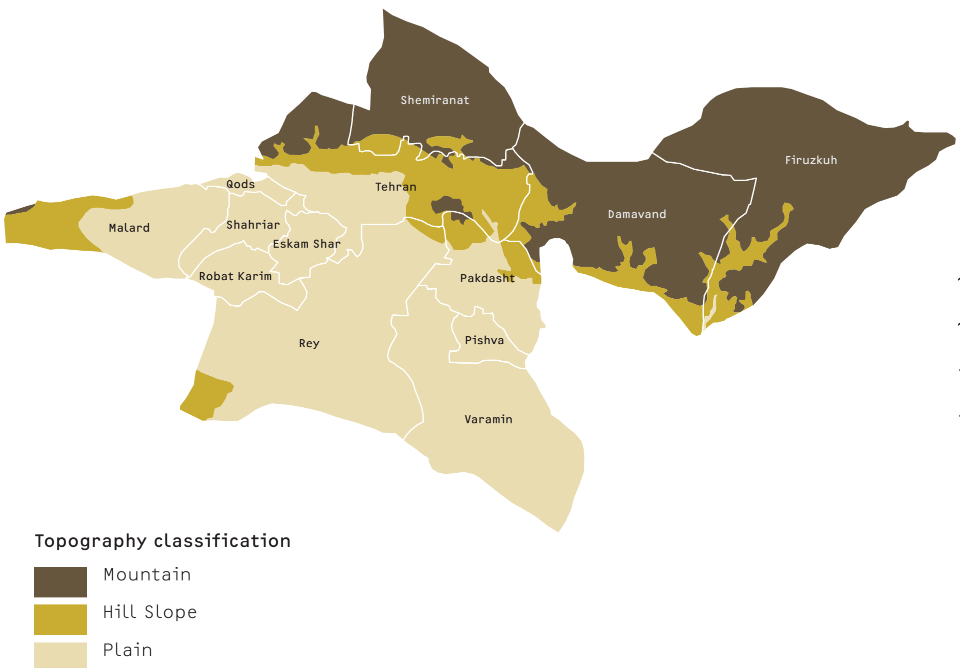


Fig. 82: Latest administrative subdivision and topography of Tehran province (based on Statistical Center of Iran 2011 and Tehran Municipality 2013)

2.1 Historical Development of Tehran

The city of Tehran is located in the Tehran province. In 2010, Tehran province changed its administrative divisions due to the formation of the new Alborz province as the 31st province of Iran. The city of Tehran, in contrast to the more ancient cities of Iran, has a short history of urbanization. Its origin is as "a village outside the ancient city of Ray" and Tehran began to grow as a city around the time that Ray started to decline (Madanipour 2006).

Tehran became the capital of Iran in 1786, when the first Qajar king was crowned in the city and began to expand the royal palace and fortresses (Habibi and Hourcade 2005). Tehran has experienced several phases of restructuring and growth defined by the city walls. The first was the original construction of walls in the Safavid period. These were demolished and new ones were constructed to accommodate the city's growth in the Qajar period. They were demolished again in the first Pahlavi period.

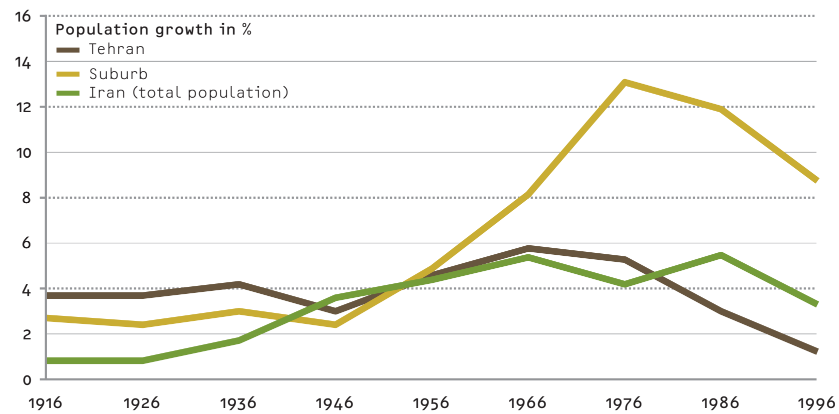


Fig. 83: Comparison of annual population growth rates for Tehran, Tehran's suburbs, and Iran as a whole (Habibi and Hourcade 2005)

Tehran has been the scene of contemporary change and transition in Iran. The city has witnessed two revolutions: the Constitution Revolution and the Islamic Revolution. It was also the scene for manifestation of modernism or semi-modernism in Iran. Tehran was from the very beginning a combination of west and east (with eastern values more dominant) both in its culture and its physical characteristics.

2.2 Administrative and Geographic Context

With an area of about 700 square kilometers, the city of Tehran is bordered by the Alborz Mountain to the north, Lavasanat to the east, Karaj to the west, and Varamin to the south (Habibi and Hourcade 2005).

Tehran's unique location has affected its growth and development. It is on the southern slopes of the Alborz mountains and is surrounded by mountains to both the north and east. This creates a natural barrier for Tehran's growth. The Dasht-e-Kavir desert on its southern edge also limits growth. The city's expansion has concentrated on its western side and partly to the south (Habibi and Hourcade 2005).

2.3 Demographic Development and Urbanization

During the 20th century, Tehran's population grew rapidly, resulting in its metamorphous from a small town to a metropolis. Other cities of the province have also grown very fast, and as the city of Tehran's population growth began a gradual decrease, they continued to absorb more population (Habibi and Hourcade 2005). In other words, the city of Tehran has reached a stable position, while its hinterland and peripheral areas are still growing (Davoudpour 2009). Among the main reasons for this population shift are: access to more affordable housing, the better natural environment of the peripheral areas, the bountiful physical and ecological assets of Tehran, as well as the strict rules imposed on its growth. City of Karaj is a good example: it has grown from a small town in a rural area to a city with more than one million inhabitants which is now the capital of the newly established Alborz province.

In 2006 Tehran province had more than 13 million inhabitants. Although the 2010 separation of the Alborz province took about 2.5 million inhabitants, the population of Tehran province had grown and was 12 million in 2011, which is more than 16% of the total population of Iran. Other provinces with a considerable share of population include the Khorasan Razavi province with 8%, and the Isfahan, Khouzestan, and Fars province each with around 6%. The remaining provinces are sparsely populated (Statistical Center of Iran 2011).

In 2006, Tehran province included 51 municipalities and 1,536 villages. Approximately 91.34% of its inhabitants reside in urban areas and 8.65% in rural areas (Statistical Center of Iran 2006). The major agglomeration is the city of Tehran, which counted nearly 7.8 million inhabitants in 2006.

Tehran metropolitan area is one of the largest urban agglomerations in the world. According to the ranking done by the Population Division of the United Nations Department of Economic and Social Affairs, Tehran will have the ranking of 30 out of 30 among the largest urban areas in the world in 2015 (UN 2005). Cairo will be the only metropolitan area located in the MENA region with the bigger population (ranking of 14 in 2015). Table 6 shows Tehran's rapid population growth since 1970 with projections through 2015. Tehran was not mentioned on the list of the world's 30 largest urban areas before 1970, but since this time it has grown rapidly, ranking 23rd in 1980 and 1985. However, after this period, which is roughly coincided with the end of the eight year Iran–Iraq war, its world ranking started to decline.

Year	Population of Tehran	Ranking
1970	3,290,000	30
1975	4,273,000	25
1980	5,079,000	23
1985	5,839,000	23
1990	6,365,000	25
1995	6,687,000	25
2000	6,979,000	27
2005	7,314,000	28
2010	7,807,000	29
2015	8,432,000	30

Tab. 6: Changes in Tehran's population and world ranking in the UN's 30 largest agglomerations by population size (based on UN 2005)

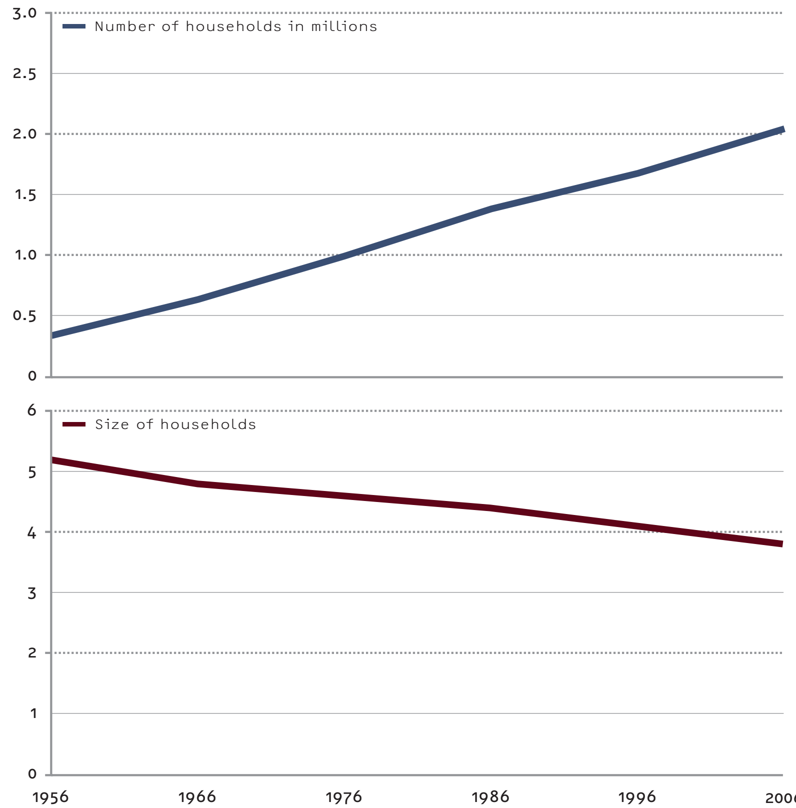


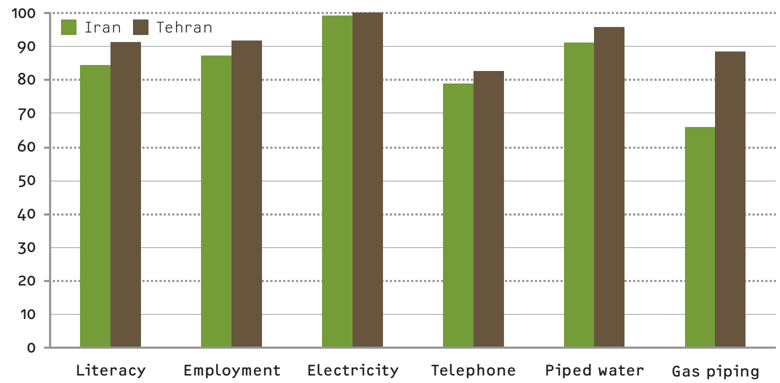
Fig. 84: Trends in the number and size of households in the city of Tehran 1956–2006 (based on Rezazadeh and Outadi 2008, Statistical Center of Iran 2006)

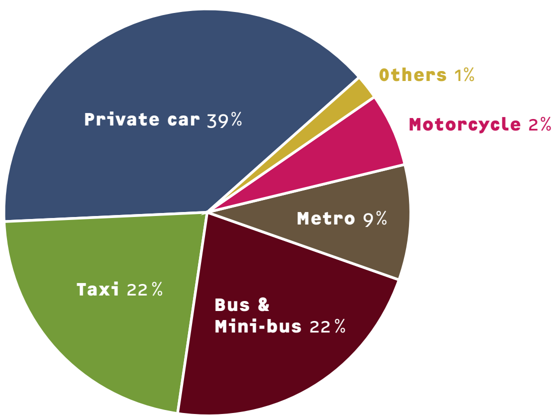
Households are also developing in Tehran, demographic data shows a growth trend in household numbers which is slightly greater than population growth. During the 50 year period from 1956 to 2006, the annual population growth rate was 3%, while the number of households increased by 3.7% annually. At the same time, household size has gradually decreased. This demographic trend is the result of socio-economic transition in Iran beginning in the 20th century and caused by “the shift of [the] economic base from agriculture in favour of industry and services” (Encyclopædia Britannica n.d.). One of the main consequences of this trend is the replacement of extended family units with nuclear ones. The higher participation of women in both economic activities and education, coupled with the high expenses of urban living are further contributing factors for the trend towards smaller households. As each family wants its own individual residential unit, these demographic trends translate into a growing demand for housing units, which is, in turn, leading to greater energy consumption.

2.4 Social and Economic Context

Rapid population growth in Tehran started in the mid 1900s and continues today, although at a reduced pace. Since the early stages of its growth there has been economic and social inequality between Tehran and its surrounding hinterland. Similar inequalities could be seen within the city of Tehran: the wealthy live in North Tehran, while the south of the city is home to relatively poor inhabitants and the center contains the rapidly growing middle class. Informal settlements in small towns and villages located around the city are of an even lower economic level. This contrast between center-periphery and north-south is a key characteristic of the metropolitan area. Tehran is the most developed province in the country. It has the highest position in most development indexes and is the economic and political center of the country. According to the national census of 2006, the literacy rate, employment and access to main infrastructures such as telephone, piped water and gas are all higher in Tehran than in the rest of the country.

Both income and living costs are higher in Tehran than in other provinces of the country (Statistical Center of Iran 2011). For example, living costs in Tehran are about 1.5 times that of Sistan-va-balouchestan province. Rent usually takes a large share of total household non-food expenditure and is one of the main challenges facing young couples. It is the reason younger generation couples from lower income groups must live in suburban areas with lower, more affordable rents but also more difficult accessibility.





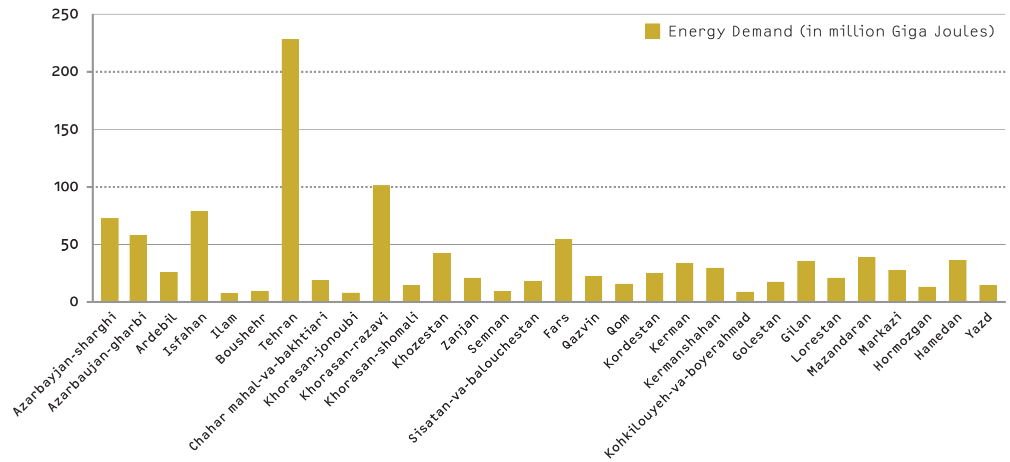


Fig. 85: Effective household energy use in Tehran by activity (Nourouzpour 2010)

Fig. 86: Comparison of selected social and economic indexes for Tehran province and Iran (Statistical Center of Iran 2006) | Fig. 87: Total effective household energy demand in the provinces in 2007 (based on Nourouzpour 2010)

2.5 Energy Consumption and CO_2 Emissions

As the political and economic center of Iran and residence of higher income groups, Tehran has greater energy consumption. In combination with higher population, more access to household facilities, and a greater percentage of residential area, effective energy demand in Tehran province is the highest in the whole country (Nourouzpour 2010).

Fossil fuels are the main source of energy in Tehran, especially natural gas. There are some supportive government plans for the use of CNG (compressed natural gas) vehicles, which have a reduced environmental impact. Electricity is the common energy source for lighting and cooling systems. In Tehran province, natural gas provides much of the energy for cooking, heating, and hot water. Piped natural gas infrastructure has been widely developed during the last 20 years, and access to piped gas is possible in most parts of the metropolitan area. This energy carrier has gradually replaced Liquefied Petroleum Gas, which was the former main source for cooking, heating and hot water. Other energy sources for cooking, heating and hot water, which are very rarely used, are kerosene, diesel, electricity, and solid fuels (Statistical Center of Iran 2006).

Compared with other provinces, inhabitants of Tehran province cool or heat more rooms within their residential units. Data released by the Statistical Center of Iran (2011) shows that on average Iranian urban families heat 77.1% and cool 67.7% of their total floor area while inhabitants of Tehran heat 91.7% and cool 90.4% of their units.

Vehicle exhaust is the main source of CO_2 emission and air pollution in Tehran. A case study shows that among four popular vehicles (bus, taxi, private car and motorcycle), private car has the highest (88%) contribution of CO_2 emission (Kakouei et al. 2012).

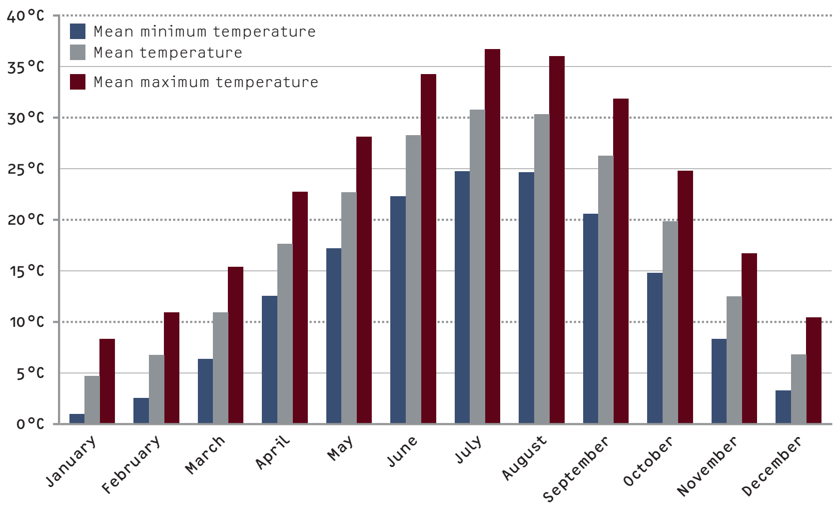


Fig. 88: Monthly mean maximum, mean mininimum, and mean temperatures in Tehran based on 1985–2006 data from the Mehrabad Synoptic station (own illustration based on data from Langer 2012)

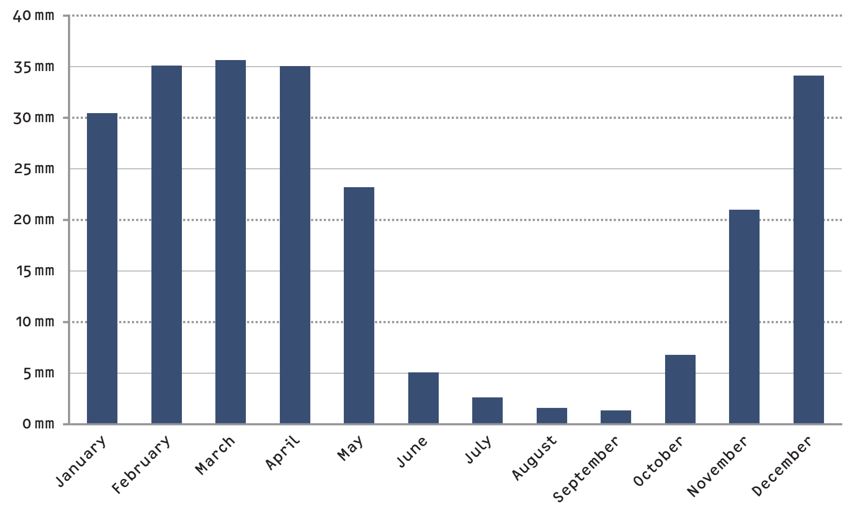


Fig. 89: Monthly mean precipitation in Tehran based on 1979–2010 data from the Mehrabad Synoptic station (own illustration based on data from Tehran province Statistical Yearbook 2010)

2.6 Climate Conditions and Trends

Tehran has an arid climate (classification BSh after Köppen climatic classification, cp. V 1). It is largely defined by its geographic location, with the Alborz mountains in its north and the central desert to the south. The hottest month is July (mean maximum temperature 36°C, mean minimum 24°C) and the coldest month is January (mean maximum temperature 7°C, mean minimum 1°C). The average annual precipitation for Tehran Mehrabad is about 268 mm/year. The majority of precipitation occurs from late-autumn to mid-spring, with almost no rain from June to September.

Roshan et al. (2010) and Alijani (2008) revealed important trends indicative of climate change by comparing data from 1953 till 2006 on relevant climate factors for the the City of Tehran. Data on the daily mean temperature reveals a significant increasing trend which is most obvious in the summer months. The annual relative humidity also showed a significant increase. Annual average rainfall showed an increase too, but it was not found to be statistically significant. Annual average wind speed shows that wind speed has decreased since 1953.

In research on heat island effects in Tehran, micro-climatic data of Tehran has been compared with that of Varamin (a less developed urban area near Tehran) for a 40-year period from 1956 through 1995 (Ranjbar Saadatabadi et al. 2006). The results show considerable increasing of minimum temperature compared with that of maximum temperature in Tehran. Gradual increasing of average annual minimum temperature in Tehran is four times more than Varamin. The main reason for this increase is human-sourced heating, the result of urban heat islands and changes in the micro-climatic condition of Tehran.

2.7 Water Resources

The Alborz mountains in the north of Tehran are an excellent site for funneling precipitation into rich rivers. There are many rivers in the province, and they are often used for industry and agricultural purposes. The most important rivers include Hableh, Lar, Jajrood, and Karaj.

For many years, Tehran was well known for its pure, clean water sourced from springs and Qanats, water management systems, originating in the Alborz mountains. With the rapid population growth of Tehran, this traditional water supply system became insufficient for the number and demand of inhabitants. Karaj River, and later other rivers in the region, was targeted as a new source of water. In 1927 the construction of Karaj-Tehran canal started and in 1963 Amir Kabir dam was constructed to provide the necessary water and to control flow changes due to precipitation.

As the population increased further, so too did the need for more water, leading to the construction of the Latyan and Lar dams. However, this level of surface water provision was soon unable to meet the needs of the city, and the use of groundwater resources started in 1963. Today, a considerable part of the city's water needs, especially for irrigating green spaces, orchards and farms, is supplied by wells constructed both inside and outside of the city (Tehran Municipality 2013).

2.8 Vegetation and Protected Areas

Tehran has three large zones of vegetative cover which correspond with the three topographic zones of the region: mountain, mountain-slope, and desert. The high mountain range of Alborz has snow-covered tops

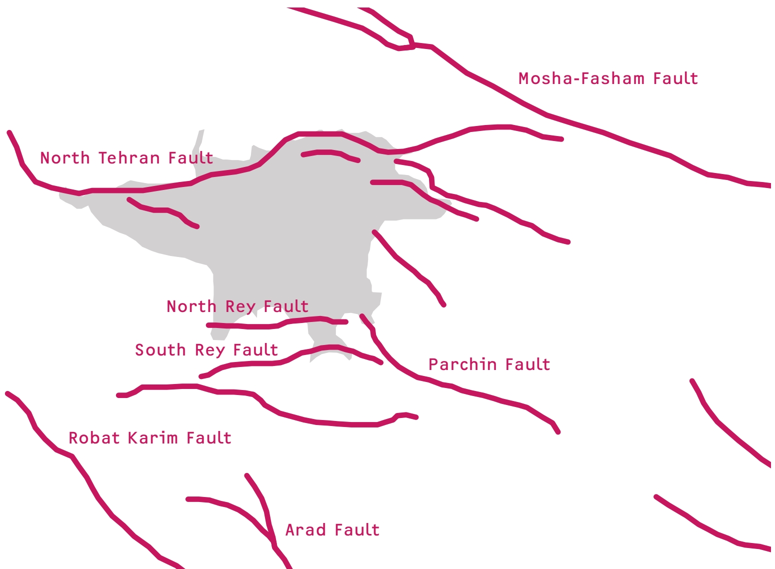


Fig. 90: Distribution of Tehran faults (own illustration based on Tehran Municipality 2013)

in winter. The northern slopes have tick forests (Hyrcanian forests) and the southern ones, near Tehran, include mountain pastures, steppes, and separated pieces of pinaceae forests (Habibi and Hourcade 2005). Most of Tehran's ecologically valuable and protected areas are located along its northern and eastern sides, and are composed high mountains and some rivers. Destruction of natural environment in the Tehran region started in the early 20th century. The main forms of environmental degradation include: destruction of the coniferous forests on the southern slopes of the Alborz and damages to agricultural zones in Tehran's southern periphery.

2.9 Natural Hazards

The Tehran metropolitan region is located in an earthquake prone area. The city is surrounded by several faults, each of which may cause severe damage if active, and, in the case of their simultaneous activation, the damage would be sweeping (Tehran Municipality 2013). Although construction technology and building quality in Tehran might be higher in comparison with other regions of the country, land speculation and growth of informal settlements has led developers to treat earthquake design codes less seriously. Therefore, there is great potential for building collapse and associated loss of life. Further, the dense urban fabric and narrow streets of some parts of the city will make post-disaster rescue very difficult which may cause another wave of preventable fatalities a few hours after an earthquake. Tehran municipality, in cooperation with the Ministry of Road and Urban Development, has urgent plans to reconstruct these vulnerable areas which are referred to officially as "deteriorated urban fabrics".

3 Urban Challenges in Iran and Tehran

Mahta Mirmoghtadaee

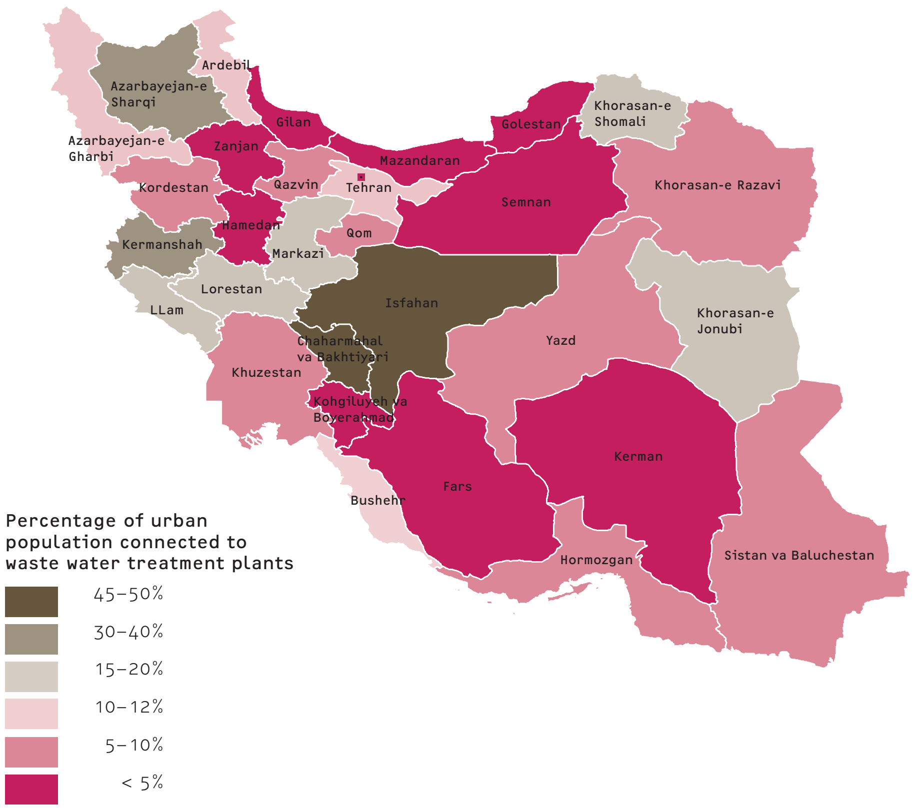


Fig. 91: Percentage of urban population connected to waste water treatment plants (based on Mohajeri and Nuñez von Voigt 2011, p.31)

Iranian urban challenges are similar to those of other urban agglomerations, in the MENA region (cp. II) but also in the world, especially when it comes to climate change and urban population growth. However, this section will highlight some urban challenges which are specific to Iran, as well as several aspects pertinent to the city of Tehran as the largest of Iranian cities (see boxes).

3.1 General Climate Change Challenges

There is extensive literature on Iran's vulnerability to climate change impacts. The country's dry climate, scarce water resources, limited forest cover, periodic droughts, and floods have already caused shortages and limitations for many Iranians in the past. The situation will only be exacerbated by rising temperatures and climate change effects such as an increasing number of hot or dry days, extreme events of heavy rainfall, and floods.

Iranian cities are both accelerators and victims of climate change. The extensive energy consumption and CO_2 emissions of Iran's residential and transportation sectors makes the role of Iran's cities in climate change obvious (cp. IV 1 and IV 2). Continued urbanization will further increase this role in the future. The impacts of climate change on cities and urban areas include but are not limited to (UNDP and DoE 2010):

- Increasing droughts will reduce agricultural production, raise unemployment, and increase migration from rural to urban areas.
- Floods may affect water resources, aggravating cities's water supply problems. Sea level rise will affect cities and villages located in the coastal areas and may cause damage to coastal infrastructures.
- The affects of changes in temperature, namely an increase in minimum temperatures, the reduction of daily temperature variability, and general warming, will be magnified in large cities and metropolitan areas. Urban heat islands will amplify the need for cooling in summer. As the use of cooling technology increases, so in turn will the energy demand, and often the water demand (for adiabatic evaporative cooling systems).
- Water pollution, combined with increasing temperatures and heavy rainfall will increase the risk for vector borne diseases such as

malaria, leishmaniasis, cholera, and diarrhea – constituting one of the main health related consequences of climate change.

- Air pollution, especially in metropolitan areas, will increase the rate of strokes, as well as cardiovascular and respiratory diseases.
- Dust storms will further worsen the situation in Iran, especially in coastal cities of western half of the Persian Gulf.

3.2 Water Scarcity and Quality

Given the scarce water resources in most of Iran, climate conditions and trends (cp. I, V 1, and V 2) will very likely increase water stress and scarcity in the country's near future.

The ongoing urbanization, population growth, and rising living standards are steadily increasing water consumption, especially in the cities. Apart from water shortages, it is the inefficiency in management and distribution of water which is considered as the system's major problem, specifically inefficient supply networks, low drinking water quality, and insufficient waste water collection systems (MoE 2005).

3.3 Waste Water and Solid Waste Management

Most of the urban population in Iran have piped drinking water. However, less than 40% of Iranian cities are connected to the sewage system (NWWEC 2011). Many are still using traditional waste water collection

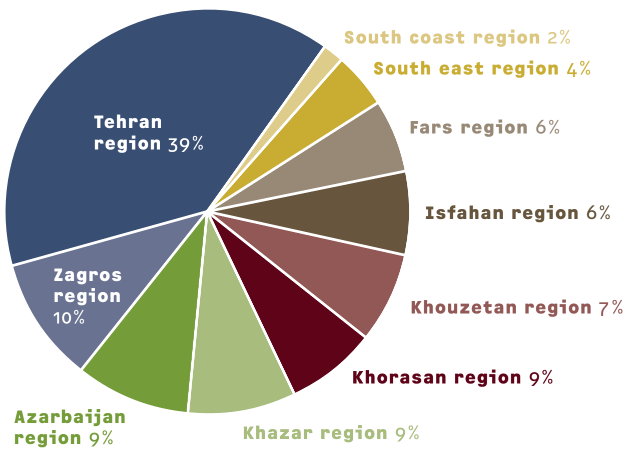


Fig. 92: The 2004 share of municipal solid waste for ten regions of Iran (Hassanvand et al. 2008)

systems based on injection wells. This type of disposal has contaminated groundwater resources, raised the water table, and degraded surface water channels (Tajrishy and Abrishamchi 2005).

The disposal of municipal solid waste is another environmental challenge in Iranian cities. In 2004, municipal solid waste production in urban areas was 0.64 kg per capita/day. Only 6% of the waste was recycled, 10% was treated at organic waste (composting) plants, and about 84% was dis-

Tehran > Water Scarcity and Quality

Fig. 93: Water pipe in the southeast of Tehran (Mirmoghtadaee)

Tehran is located in an area with abundant water resources compared to many other Iranian cities. However, its rapid population growth and concentration of economic activities, coupled with periodic drought and heat island effects, has caused serious water stress in recent years. The water consumption behavior of the inhabitants is also a major problem, according to the head of "Tehran Province Water and Wastewater," per capita consumption is two times more than the world average (Shabakenews 2012).

Tehran > Wastewater and Solid Waste Management

Fig. 94: Water Treatment Plant in Tehran (Gomarian)

Tehran still uses a traditional wastewater collection system based on injection wells (Tehran Municipality 2013). The development of a modern sewage collection and treatment system is still in progress.

The main problem for Tehran's solid waste management is the massive amount of waste (7,641 tons/day in 2008) produced by the rapidly increasing population of Tehran (Abduli and Azimi 2010) (cp. Fig. 92). Currently, most of the waste is disposed of in a landfill located in Kahrizak region, south of Tehran.

Tehran > Air Pollution

Fig. 95: Air pollution in Tehran (Gomarian)

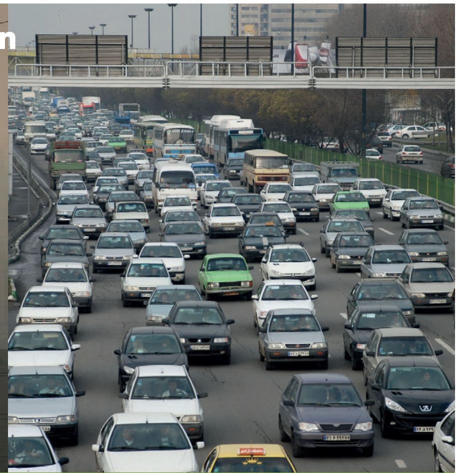


Fig. 96: Daily traffic jam in Tehran (Gomarian)

Tehran's location, with high mountains to the north and part of the east, coupled with heavy traffic and dominant winds from the west which carry pollution from surrounding factories into the city, creates dramatically unhealthy climatic conditions for inhabitants. In cold winter months the air pollution is made more severe by temperature inversion trapping pollution in the lower levels of the air column (Tehran Province Statistical Yearbook 2010). Some past legislation and plans have tried to tackle the problem. The most important of these was the "Comprehensive plan for air pollution reduction in Tehran" which focused on transportation issues such as public transportation, technical inspection of vehicles, fuel combustion, transportation management, replacement of old vehicles with the new ones, and education (Roshanzamir et al. 2001). However, it was only partly successful and Tehran is still ranked among the worst cities for severe fine particle air pollution globally, with more than a third of the year characterized by unhealthy air pollution levels (Brajer et al. 2012).
Climate change will reduce wind, increasing the number of calm days and worsening the current pollution effects. Although total precipitation will not decrease, the potential decrease in the number of rainy days will reduce the removal of pollutant gases and particles from city air (Alijani 2008).

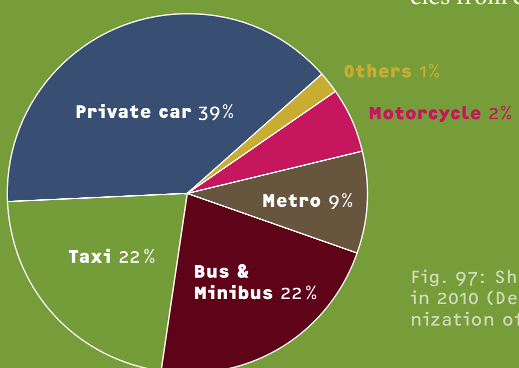


Fig. 97: Share of daily trips in Tehran in 2010 (Deputy of Transportation Organization of Tehran Municipality 2010)

posed of in landfills (Hassanvand et al. 2008). Handling the large amount of solid waste is a major problem, especially in metropolitan areas such as Tehran, which in 2004 produced about 40% of the entire country's total municipal solid waste (see Fig. 92). Iran's waste disposal system and recycling rate are both in need of improvement (Abduli and Azimi 2010).

3.4 Air Pollution

Reducing air pollution from fossil fuel combustion is an important challenge for Iranian urban agglomerations. The transportation sector is among the most polluting. Due to insufficient public transportation, private cars make up more of inner city trips than all other forms of transportation (see Fig. 98). While there is a gradual continuous increase in all transportation modes, car trips show a slightly higher growth rate compared to public transportation modes (e.g. bus, mini bus and collective taxis). This only exacerbates the air pollution challenge, as the private cars are responsible for a much greater share of emissions (see Table 7).

3.5 Urban Planning and Governance

The local government is responsible for urban management and the implementation of rules, regulations, and planning documents - great tasks for which municipalities have limited resources. Comprehensive and detailed plans are the main legal documents for controlling land-use planning and development of urban areas. However, Iranian municipalities have limited control over the content of those plans, as they were prepared and approved by the "Ministry of Road and Urban Development". Their top-down, rigid approach, based on a time consuming preparation

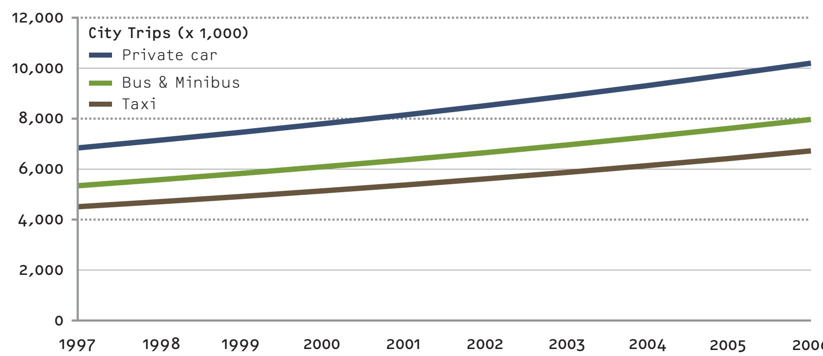


Fig. 98: Annual average city trips in Tehran, Karaj, Tabriz, Isfahan, Shiraz, Mashhad, Qom, Ahvaz (based on data from Iranian Fuel Conservation Company 2009).

and approval processes, and a lack of flexibility in dealing with changing situations drew criticism, causing a long debate among academics and professional urban planners of Iran. The result was the substitution of strategic plans as a more flexible method (Fahrhoodi et al. 2009). This change in planning process is still in its preliminary stages and more experience is needed to ensure its development and progress. City authorities must also deal with land speculation and unplanned development as well as the huge challenges of infrastructure improvement and maintenance. These hurdles significantly influence the implementation of sustainable solutions in Iran's urban development and urban form.

Land speculation and urban sprawl

Due to economic and social factors, the Iranian real estate market was considered to be a profitable and safe investment. In seeking a profit, developers try to finish their housing projects with the lowest possible investment and shortest possible time. In doing so, they often violate municipal rules and codes and tend to use low quality materials. This, coupled with the development of unplanned settlements, is considered the main reason behind the poor construction quality of residential units and the formation of Iran's "deteriorated urban fabric" is one of the consequences. Development of scattered and informal settlements is another factor behind Iran's inefficient infrastructure. As municipalities lag behind the rapid development process, many cities lack sufficient social and technical infrastructure.

Urban services and infrastructures

Since the beginning of rapid urbanization in the 20th century, housing has been a major issue both for Iran's central government and municipalities. With the goal of providing shelter, especially for low and middle income groups, housing projects have always been an urgent task of the government. However, in many cases, the construction of residential complexes was not coordinated with development of urban services and infrastructures such as efficient public transportation systems. Iran's municipalities and metropolitan areas have begun to improve on this in recent decades, developing public transportation systems with Bus Rapid Transit lines and underground railway systems. However, further development of public transportation is still a challenge in many cities.

Pollutant	Private car	Van	Motor-cycle	Mini-bus	Bus	Truck	Mini-truck
CO	1,196,592	413,245	166,136	9,712	10,616	3,400	110,910
NO_x	567,473	195,978	78,789	37,766	41,282	13,224	431,309
SPM	23,969	8,278	3,328	9,991	10,921	3,498	114,098
CH	1,162,755	401,559	161,438	16,690	18,244	5,844	190,612

Tab. 7: Iran's 2006 emissions (in tons) from transportation (based on data from Iranian Fuel Conservation Company 2009).

Tehran > Urban Planning and Governance

Fig. 99: Look over Tehran (Gomarian)

The Tehran municipality is a very strong organization with big responsibilities: dealing with the complicated and increasing problems of a metropolis is a difficult task. Air pollution, insufficient public transportation and urban infrastructure, traffic congestion, environmental degradation, low green space coverage, and vulnerability to natural hazards are among the major issues to be tackled.

Lack of integrated urban management and limited financial resources are among main challenges of urban administration in Tehran. Since early 90s, Tehran started to allow higher densities through bonus zoning: "developers could build taller buildings by paying fees to the municipality, in a policy popularly known as 'selling density'" (Madanipour 2006). This was a route for the municipality to gain financial autonomy, but the policy caused disorder and chaos in Tehran's urban form. Although this policy is restricted in newer planning documents, the municipality still needs this source of income to fund civil projects.

According to Roshan (2010), Tehran is characterized by disintegrated and sprawl-like growth during recent decades. Comparing the population growth rate with the city's physical expansion shows that in the last 85 years, the population of the city multiplied by 37, while in the same period, its area increased by 100. Beyond rapid growth, the city's expansion has been unplanned, desultory, and dispersed - the typical characteristics of sprawl. High land prices, which many people can't afford, and speculation impinge on any attempt to create a compact urban form.

Moreover, with housing development in Tehran so profitable, there is less willingness to develop green spaces and parks in the city. In fact, this profit-making trend has led to many of the city's old gardens being replaced by high rise buildings. The low and decreasing supply of open and green spaces has a significant negative affect on the local city climate.

VI

Applying the Approaches of Resource-Efficient and Climate-Sensitive Urban Design on the Shahre Javan Community Pilot Area in Hashtgerd New Town, Iran

This chapter concentrates on the approaches of resource-efficient and climate-sensitive urban design applied to the Shahre Javan Community pilot project in Hashtgerd New Town, Iran. After a general description of the case study's settings, Section 1 focuses on the integrated planning and research process and Section 2 briefly summarizes the case study results. Both sections function as a framework for the subsequent sections authored by the Young Cities research team's participating disciplines. Each section details the steps and measures the discipline undertook in developing their neighborhood design solutions for the Shahre Javan Community.

Climatic, Topographic, and Geologic Case Study Settings

Annette Wolpert | Sebastian Seelig

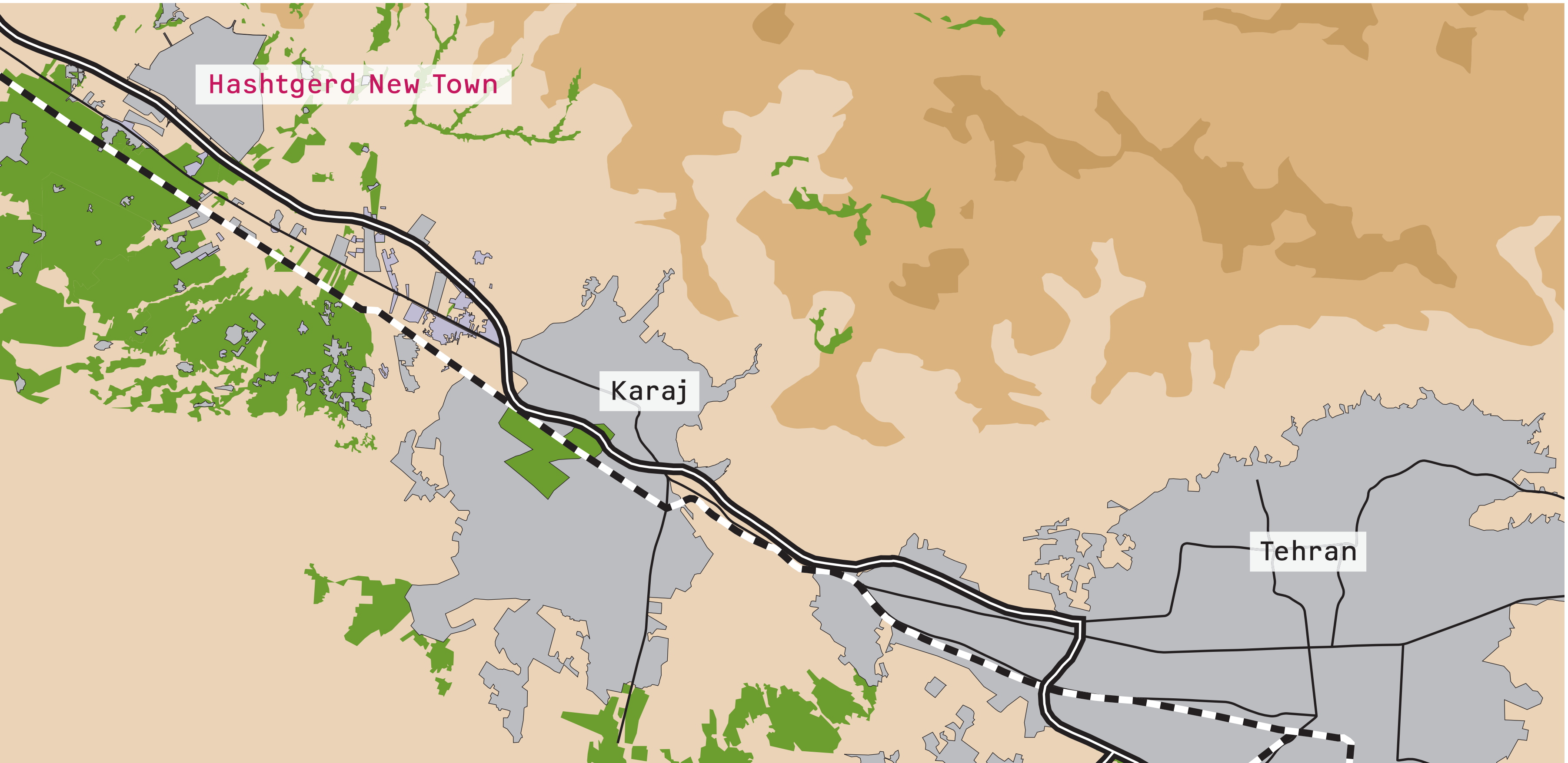


Fig. 100: Location of Hashtgerd New Town (Young Cities Project)

Hashtgerd New Town is located on the southern slopes of the Alborz mountains in the western part of the Alborz province, some 25, 60, and 75 km from the neighboring major cities of Karaj and Tehran to the east, and Qazvin to the west, respectively.

The major, significant natural features around the city include the Alborz mountain range (rising 2,800 to 3,200 m high) as well as the Fashand and Kordan rivers to the west and east of the city. Also important are the northern Taleghan Valley and Abyek plain, both of which greatly affect the morphology of the area, creating the following unique characteristics (Khodabakhsh, Fathejalali and Pakzad 2012, p. 24f.):

- an average north to south slope of 5% throughout the city,
- a series of small valleys with side slopes of 20% to 50%, and
- high sloped rivers.

The Shahre Javan Community pilot area is located in the southern portion of Hashtgerd New Town and, thus, in the low-lying part of town.

The Tehran region is characterized by a distinctive climatic and topographic situation, which requires specific strategies for the built environment. According to Köppen's climate classification Tehran Province is located in a semi-arid climate zone with warmer areas (City of Tehran) and colder areas (towards Hashtgerd) created by the region's topography (Müller 1983). The area is also characterized by large seasonal variances: In summer, temperatures can reach maximum values of more than 35°C followed by relatively cold winter periods with rainfall and snow. In addition to these seasonal, the summer also has strong diurnal variations. Winds are mainly westerly, transporting cold and moist air from the Mediterranean regions. In summer, winds from the south and southeast, which are very warm, dry, and dusty due to their origin in the Kavir desert, also occur.

The low annual rainfall of 300 mm comes mainly as snow in the winter periods and though scarce, it provides a reliable source of water for the region's residents. As the effects of climate change are increasingly felt in the region, the situation will most likely become more and more critical. Regional climate forecasts predict that the rising mean temperature of Iran will increase the runoff volume during winter but decrease the runoff during spring as the rising temperature turns snowfall into rain and shortens the snow melt. Thus, water scarcity is one of the major concerns of the region.

The urban development in the Tehran-Karaj region is strongly determined by the distinctive topography. The region is partly located on the southern slopes of the Alborz mountains (ranging from 900 to 1,700 m). This high mountain barrier has limited the settlement development to the north. To the south, the desert acts as a barrier against expansion, although it is less definitive than the mountains.

Due to the missing natural barrier to the west the development of settlements has gradually stretched from the city of Tehran towards the city of Karaj.

A third regional feature is the high earthquake risk and vulnerability to natural hazards. The Tehran region is exposed to constant seismic threat, since one of the region's main geological features is its location between the southern slopes of the huge mass of the central Alborz mountains and the Iranian plateau. The rupture between the Alborz mountains and the Iranian plateau is one of the largest of its kind in the world. This rupture is characterized by a series of faults, which are constantly active and create slight tremors (Hourcarde 2005). If they become active simultaneously, they stand to be a major threat for the region, although no event has occurred in the past few centuries.

1 Urban Planning for a Climate-Sensitive and Resource-Efficient Neighborhood in the Tehran Region

Annette Wolpert | Sebastian Seelig

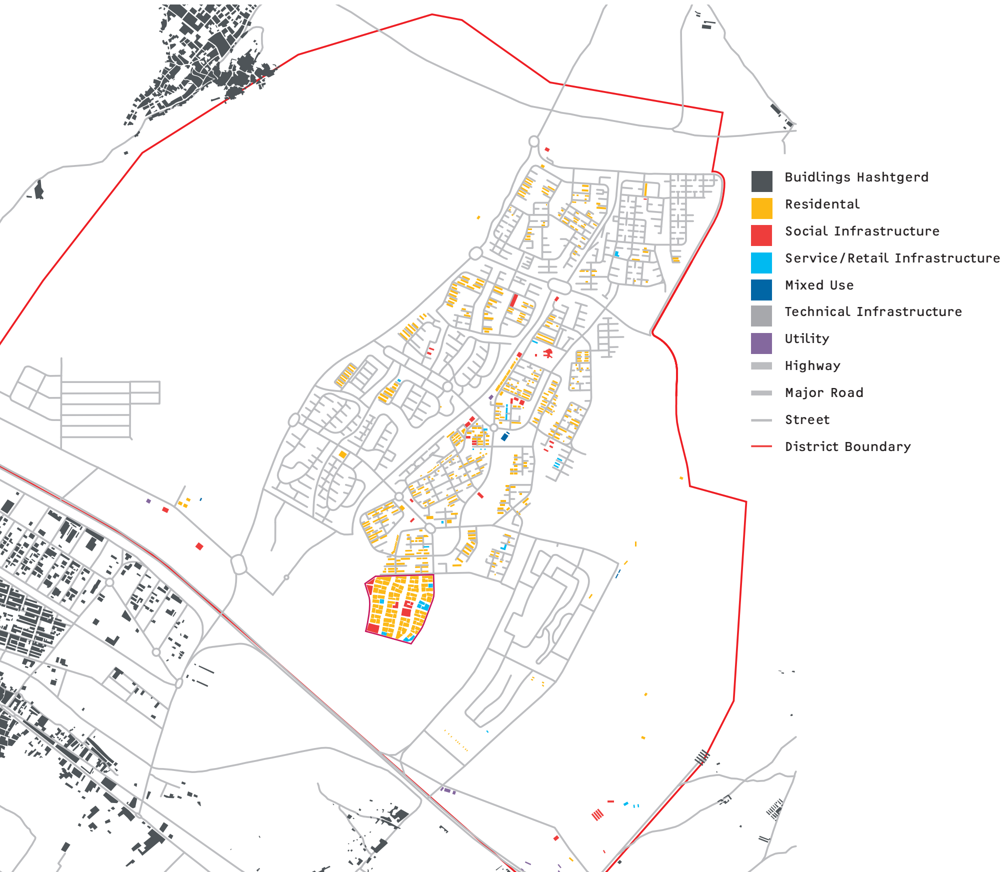


Fig. 101: Hashtgerd New Town (red boardered) with current road system, existing buildings and (not realized) Shahre Javan Community pilot area

The Shahre Javan Community is a 35 ha housing quarter with additional 9 ha open and green space. It offers room for 2,000 Housing units and 8,000 inhabitants, complemented with a social and cultural center, office space and retail units. These neighborhoods were planned in a comprehensive process with the aim to find energy and resource-efficient solutions integrating the fields urban form, architecture, landscape and transportation planning, water and wastewater management, energy management, environmental assessment and public participation.

The Shahre Javan Community was developed in an interdisciplinary manner by the Strategic Dimension "Urban Planning and Urban Development" TU Berlin, led by Prof. Elke Pahl-Weber in cooperation with the Iranian partner, the team of Prof. Dr. Pakzad from

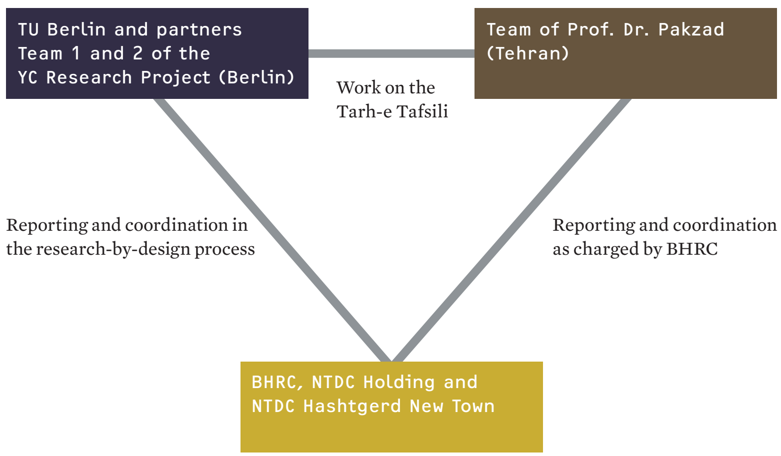


Fig. 102: Work flow for Shahre Javan Community detailed plan preparation (Seelig, Ohlenburg and Pahl-Weber 2012, p.13)

Shahid Besheshti University in Tehran as a contractor to the client of the Building and Housing Research Center (BHRC), the New Towns Development Cooperation (NTDC) and the Ministry for Housing and Urban Development (MHUD). The process was characterized through several exchanges and feedback loops.

1.1 Analysis of local situation

A former comprehensive Plan of Hashtgerd New Town (Proposal Land Use, Project No. 202-37, NTDC 1993) expected a population of 500,000 for 4,300 ha of land. But as in 2006 the population of Hashtgerd New Town reached only the number of 16,000 inhabitants, it was obvious that it`s scenario proofed unsuccessful and needed to be revised. The population goals needed to be adjusted and adapted to the demographic, social and economic changes of the modern Tehran-Karaj region.

A new comprehensive plan, effective from 2005 onwards, was taken as the authoritative framework for the Shahre Javan Community pilot area with determinations of physical aspects, access networks and with statements of the predicted economic and population development.

1.2 Aims and Methodology

Against this background, the Young Cities Project aimed for low carbon and climate change resilient housing solutions accounting for the specific climatic, environmental, cultural and economic context of Iran.

Aims were specified as followed (Pahl-Weber, Seelig and Ohlenburg, p. 10):

- Define criteria and objectives for energy efficiency in semi-arid (and potentially warm) regions on the residential scale of urban quarters;
- Develop technical and non-technical solutions for reducing energy consumption and climate change adaptation in the urban development of semi-arid regions;
- Develop and implement appropriate planning and design strategies, including evaluation of progress towards the project goals in collaboration with the Iranian partners; and
- Develop methodologies, in the form of manuals and guidelines, for energy-efficient, climate change resilient, planning and design for the Tehran-Karaj region—eventually resulting in adapted or new policies.

Methodology

The diagram (Fig. 103) shows that the design process of the Shahre Javan Community pilot project area was very complex. With three parallel tracks “planning and design”, “simulation”, followed by “documentation and analysis”, the tasks were not conducted in a linear process, but rather reciprocal, with manifold interdependencies.

well as environmental protection needed to be introduced, as so far these topics were scarcely accounted for. Furthermore rules and regulations in the common Iranian detailed plan had to be deepened.

In this context, the regulatory possibilities of the German “Bebauungsplan” were analyzed related to the possibilities of their application in Iran, in particular with regard to its energy efficiency components. The resulting detailed plan combines structure, content and procedure of the standard Iranian detailed plan with new regulations and procedural innovations derived from the German Counterpart, such as the Introduction of the Floor Area Ratio which defines the compactness of the building within the building lines and regulates building configuration and orientation or the Environmental Assessment, which describes and evaluates the environment and predicts impacts.

One can summarize the following aspects, which serve as examples for a whole range of innovations:

- Physical regulations for energy-efficient urban form,
- Consideration of environmental concerns through environmental assessment,
- Measures for compensating environmental impacts,

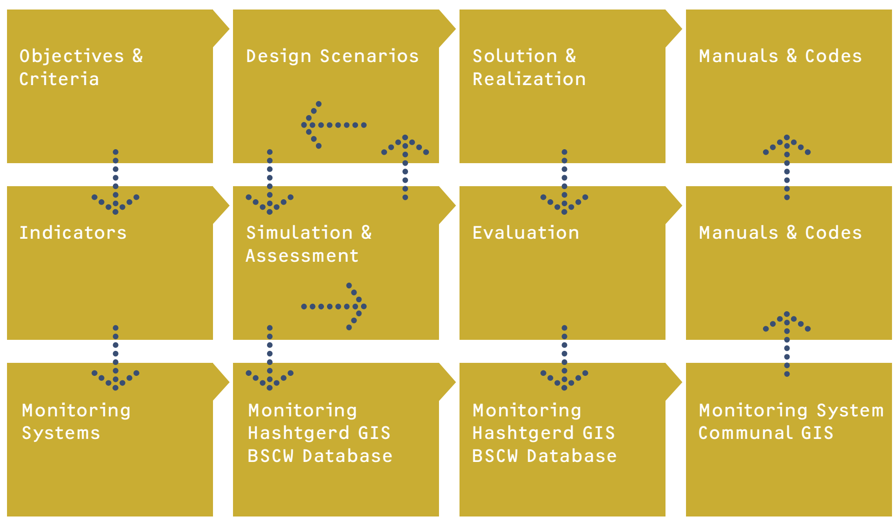


Fig. 103: Methodological approach of design, simulation and documentation of the Shahre Javan Community pilot project (Pahl-Weber, Seelig and Ohlenburg 2011, p. 61)

1.3 Objectives and Criteria

With the Iranian detailed plan ’Tarh-e Tafsili’ as a legally binding planning tool, with high potential, the German and Iranian Partners decided to base the Shahre Javan Community Detailed Plan on these existing Iranian rules on the one hand, as it projected a considerably high transferability and implementation in Iran, but that on the other hand new aspects and goals of sustainability like resource and energy efficiency as

- Physical regulations and designations for green and open spaces,
- Including both public and private interests in the plan (Pahl-Weber, Seelig and Ohlenburg 2012, p. 15).

Accompanied by further energy and resource saving measures:

- Introduction of mixed-use zones,
- Integration of aspects of public transport,

- Proposal of innovative wastewater treatment and reuse,
- Integration/proposal of decentralized heating and single building cooling systems.

In a process like this, which took one and half years, the responsibilities in the work flow needed to be clearly defined. Whilst the German Partners of the Young Cities Project, as the lead partners, were responsible for preparing the content, in form of plans, texts and other illustrations in English language as the agreed common language; Armanshar Consulting, a private company assigned by BHRC and NTDC and experienced in this field, had to translate all content into the Persian language and make editorial amendments according to formal Iranian standards. Several bilateral workshops were necessary to bring about a legally binding planning report, which was finally approved by the Iranian side in 2011.

Weighing different interests

Main part of this planning process and also a central part of the German planning law and legally binding land-use plans is the weighing of different public and private interests. Given the large number of different disciplines involved in that planning process, the aims of the single dimensions not necessarily go along with aims and requirements of others. Interest might be congruent, overlap, but they also might contradict. In this case, conflicting interest have to be weighed against one another, each given fair consideration.

Given the German planning law municipalities have to ensure that:
- Interests are duly weighed;
- All matters warranting consideration are covered;
- There is no failure to appreciate the importance of public and private interests; and
- The balance achieved is proportionate to the objective importance of different interests (Pahl-Weber, Seelig and Ohlenburg 2012, p. 19 f.).

Within these constraints one can decide in favor of one interest, a procedure that has also been applied in the planning process of the Shahre Javan Community area. As part of a research by design approach, the different interest of the disciplines involved were exemplarily conducted and weighed.

1.4 Impacts and Results

Elaborating the detailed plan in a bilateral process created impacts on two levels: On the one hand the plan provided a legally binding base for the realization phase of the Shahre Javan Community pilot project. On the other hand it demonstrated how the traditional Iranian instrument of the "Tarh-e-Tafsili" (Persian for detailed plan) was successfully provided with aspects of sustainability like resource and energy efficiency or environmental protection.

This leads to the distinction of Short-term/direct impacts or Long-term potential with regard to local ecology, economy and social, cultural and political aspects.

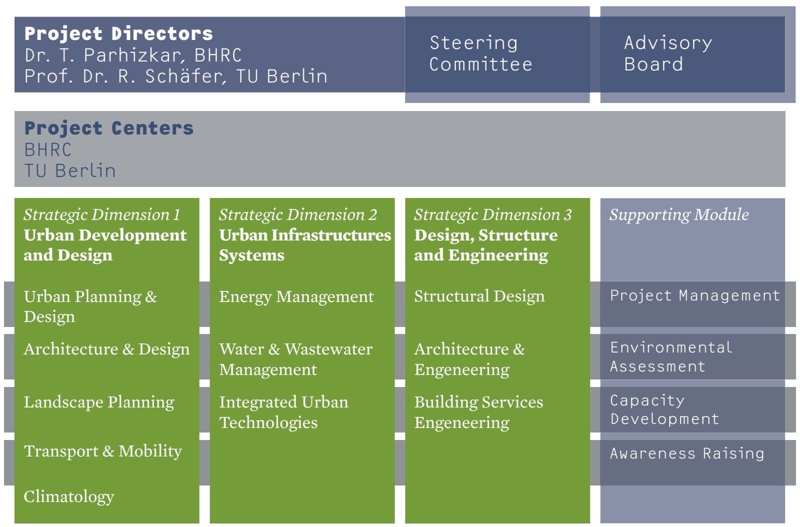


Fig. 104: Project organization chart (Seelig et al 2011, p. 43)

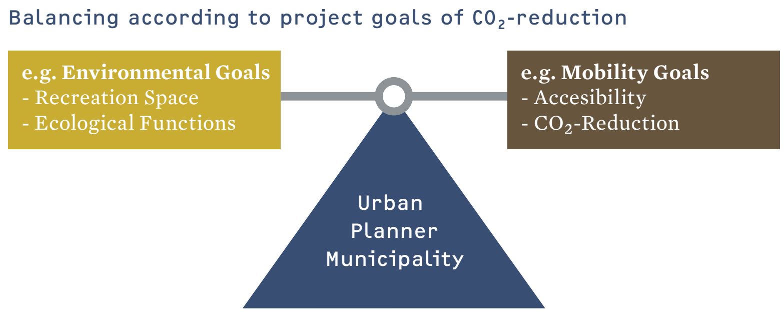


Fig. 105: Weighing of goals and interests of landscape planning, environmental planning and transport planning (Ohlenburg et al. 2012d, p. 20)

Short-term/direct impact

- Ecology: Introduction of new regulations for water treatment, energy systems, environmental compensation and a mobility concept not only for the pilot project area but also for the revised Master Plan for Hashtgerd New Town;

- Economy: As framework for elaboration of feasibility studies and governing as well as controlling tools it is a reliable basis for economic development;
- Social/cultural & political aspects: due to the improved Master plan this site is now fixed as an "Area for special Design" and all subsequent plans have to be according to the new energy and resource-efficient regulations. Furthermore the awareness of the Iranian partners for sustainable topics have been raised during this long bilateral work process.

Long-term potential

- Ecology: In case of realization of the pilot project energy and resource savings are expected, e.g. reduction of energy consumption of buildings to up to 65% through reduced heating and cooling demand, reduction of individual car trips through revised transportation and land-use plan, recycling of 50% of the used water through use of graywater for irrigation, preservation of water course and valuable green as well as realization of compensation measures due to the Environmental Assessment;
- Economy: In case of realization of the pilot project integrated measures for sustainability can be economically assessed and also low cost measures due to integrated planning and technological efforts can be evaluated in the local context;
- Social/cultural & political aspects: Approved plan could function as a blueprint for physical planning in other New Towns.

Urban Governance

Worked well:

- Methodological approach: work with existing tool, no new external solutions (better to rely on existing processes and knowledge),
- Refer to international highly accepted reference system (in this case German systems),
- Transfer and application of ideas—both instruments need to be similar in scale and regulative scope.

Improvement potential:

- Process quality—process transparency needed on both sides,
- Monitoring quality—difficult to monitor success,
- For the success of a legally binding plan and its energy efficiency the behavior of users and residents is crucial—German system of Participation has not been sufficiently transferred.

2 Energy-Efficient Design Solutions for Dense and Diverse Neighborhoods for the Shahre Javan Community

Annette Wolpert | Sebastian Seelig | Philipp Wehage

Fig. 106: Shahre Javan Community pilot project area in Hashtgerd New Town with Alborz mountains in the background, 2008 (Wehage)

Considering the local conditions and pilot area settings described ion page 130 f., it is clear that an approach adapting to the highly complex climatic, topographic, and geologic patterns is urgently needed.

Adaptive requirements for urban agglomerations of the region can be summarized as follows:

- Urban structures should react to seasonal variances—high heat stress in summer, cooler, wet winters, and strong diurnal variations;
- Urban structures should react to the topography—changes in temperature and precipitation as altitudes get higher, as well as wind directions;
- Urban structures should react to the risk of earthquakes.

Among the many already well-known elements of energy-efficient urban fabric, the technical-scientific and procedural innovations of the pilot project were achieved through strategic integration of all required planning disciplines: urban development concepts were linked to detail planning and adjusted to technologies concerning urban infrastructure (energy, water, traffic, and green spaces). This led to a multi-scale approach involving various levels—from the entire city to the single item—in order to achieve overall optimization and advancement.

2.1 Objectives and Accomplishments of the Integrated Planning Process

The task was to develop a sustainable and energy-efficient urban quarter for a population of 8000 inhabitants with approx. 2000 residential units in a central part of the already outlined area of New Hashtgerd. The "low-rise—high-density" pattern of traditional Islamic cities served as a model for a climate sensitive design, as it reflects the cultural need for privacy with its clear definition of private, semi-private, and public areas. From the very beginning of basic organization of compact urban form clusters, various requirements of different dimensions had to be considered and weighed. The height, length, and width of each block had to be considered in combination with street width and orientation in order to:

- Achieve a flexible organization of the block with a large variety of unit numbers and sizes,
- Reduce energy consumption through an optimized use of shading in summer and direct sun impact in winter,
- Optimize the channeling of wind for cooling effect and to minimize air-pollution,
- Reduce construction efforts through a low rise approach, especially in regard to seismic hazards,
- Reduce travel demand through optimized access and transportation systems,
- Minimize soil movement and sealing and preserve existing, valuable green space for recreational purposes,
- Create an urban identity through spatial design, perceivable throughout the spatial hierarchy from urban quarter to neighborhood to building.

In four rows, 28 clusters, each of approx. 100 m by 60 m, are lined up from north to south. This organization helps block the unpleasant prevailing winds from the west and northwest and the hot and dusty summer winds coming from the southeast. Furthermore, the north-south orientation of the streets helps to channel and take advantage of the cool northerly winds from the mountains in the summer. This was simulated using the microclimate simulation software Envi-met.

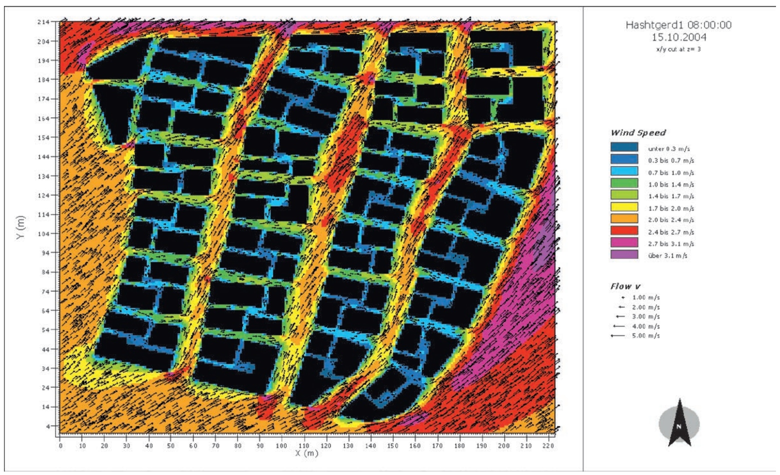


Fig. 107: Wind speed simulation within the Shahre Javan Community with Envi-met (Langer 2012)

Each residential cluster forms a sub-neighborhood with a central square of 15x30 m as a semi private focal point. The sub-neighborhoods are accessible only via 6 m wide footpaths, which divide the Cluster into four building groups. The buildings, with a maximum height of three stories (carpet style), follow the topography of the site, with a more or less continuous offset of about one story. This arrangement and ratio of built and unbuilt area together with the north-south orientation optimize the benefits of potential shading in summer (to reduce cooling demand) and projected solar incidence in winter (to reduce heating demand).

The semi-private plaza of each sub-neighborhood is part of a mixed-land-use scheme, which was combined with the urban, landscape, and transportation concept.

The mixed-use concept was composed of two layers: one central and the other de-central. Central mixed-use means that, apart from a large regional shopping center which is positioned on the southeast corner of the site, all main functions, such as the cultural center, mosque, and schools, are located in the center of the site in order to make it the focal point of urban life. The idea was that all main amenities should be within in easy walking distance of every resident. The de-central portion of the concept translates into smaller commercial units surrounding the semi-private plaza of each sub-neighborhood, accommodating the everyday needs of the residents and helping to create sub-neighborhood identity and livability.

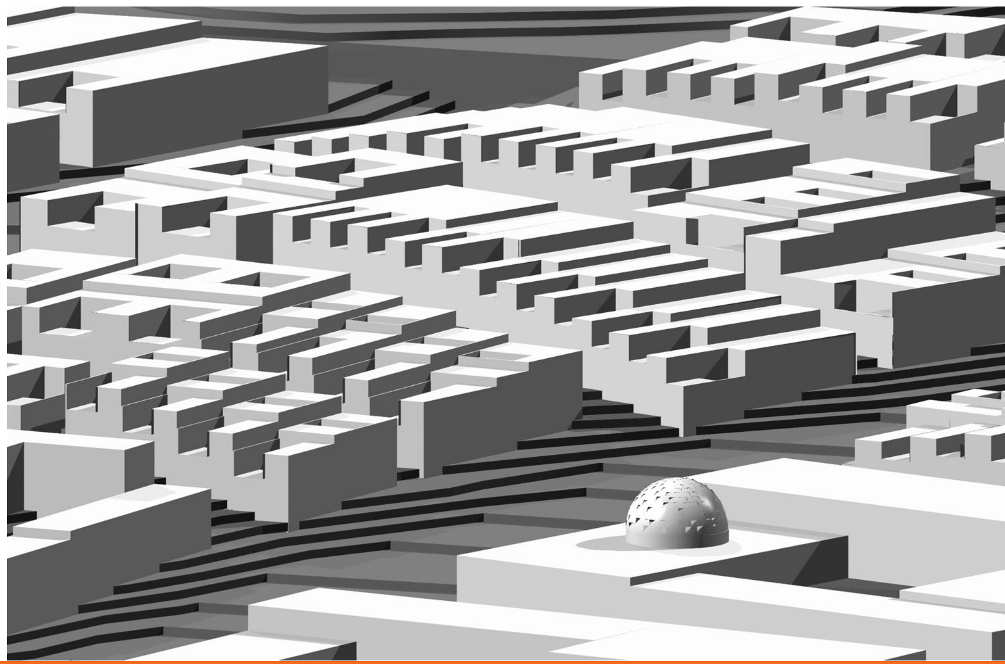


Fig. 108: 3D Rendering of the Shahre Javan Community pilot project area Urban Concept (Timme 2009)

2.2 Traffic

This layout reduces travel demand and, apart from supply and emergency traffic, keeps motorized traffic out of the residential areas (cp. VI 6). Simulations with VISUM proved that this compact urban layout and land-use concept for the Shahre Javan Community pilot project area can reduce individual car trips by 3% and the use of public transport by 7%.

An Eco-Mobility and Transportation Concept was investigated for both the Shahre Javan Community pilot project area and the region of Hashtgerd as a whole. It became obvious that too much was afforded to the future demand for individual motorized traffic and not enough for the alternative of a public transportation system. Developing a well-considered public transportation system would enable people to move out of unsustainable transportation habits, reducing individual motorized traffic. A system with a city-bus, rapid transit buses, and light rail would be sustainable, comprehensive, and integrate the Shahre Javan Community pilot project area into the larger City of Hashtgerd. These systems would also complement the planned Hashtgerd-Karaj-Tehran metro line for commuters going in and out of the City of Hashtgerd. The benefits of such a system include:

- Reduced vehicle-based mobility and, thus, energy consumption,
- Increased access to services, jobs and shopping,
- Increased flexibility to accommodate the changing needs of inhabitants and investors,
- Increased urban quality, liveability, identity, and security,
- Increased level of economic activities in residential areas.

Fig. 109: Transportation concept and land-use concept with small-scale, mixed-use areas (striped) (Schäfer et al. 2010, page 67)

The clear distinction between motorized routes and pedestrian or bicycle lanes, together with the relation between very dense built zones and unsealed, partly green corridors, also meets the demands of the Landscape Architecture, Environmental Assessment, and Water and Wastewater dimensions.

2.3 Environmental Assessment, Extensive Landscape Design, and Wastewater Reuse

The Environmental Assessment analyzed the environmental factors of flora, fauna, soils, groundwater/surface water, climate/air, and landscape, investigated the environmental impacts of the proposed urban development, and developed measures for mitigating those impacts. The compactness of the built area should reduce the amount of sealed soil while the wind channeling of the urban structure should protect or enhance the local climate by improving air quality and avoiding urban heat stress by providing a fresh supply of cool air. Valuable green structure has been preserved and measures have been proposed to develop the existing environmental structures (cp. VI 8).

The compact urban form helped create an expansion of available open space and recreational areas for the inhabitants. The project aspired to a minimum of 7 m² public greenery per capita, a standard which could be raised up to 12.5 m² per capita if the adjacent greenery will be preserved (cp. VI 7).

The water scarcity challenge has motivated the integrated development of an Extensive Landscaping Concept as well as an efficient Water and Wastewater Management System (cp. VI 5). In the early development stage, the dense and mixed use urban form was interconnected with an efficient Wastewater and Disposal Concept, which includes a separate collection of two different wastewater streams: graywater from sinks, showers, washing machines, and bath tabs and blackwater coming from kitchen sinks and toilets. After being treated in decentralized constructed wetlands, the graywater could be reused for irrigation or service water. Water treatment areas (constructed wetlands), especially graywater, should be located in the near proximity of the residential units of each sub-neighborhood. Thus, their placement had to be considered at the very beginning. The benefit of these relatively simple planning considerations is extraordinary, as they allow up to 70% of used water to be repurposed into the water cycle of the city of Hashtgerd. The introduction of constructed wetlands, with low water consuming, regionally adapted vegetation, helps to reduce the energy demand simply by reducing the need for pumping, enhances the microclimate, and improves the quality of the open spaces as a design element.

2.4 Architecture

Based on an urban concept derived from the pattern of traditional Islamic cities, the building typology of the Shahre Javan Community pilot project area is rooted in the traditional courtyard house of semi-arid and arid regions. This typology offers privacy and the courtyards' microclimates are helpful for dealing with the challenges of hot climates.

The four building plots within each sub-neighborhood are 20 to 35 m deep and predominantly orientated in a north-south direction. These large plot depths are only usable when further insertions via courtyards and niches are introduced to allow for sufficient natural daylight (cp. VI 3).

It is well known that the main environmental gains that can be achieved at the building level are through general planning principles such as orientation and compactness, followed by further energy gain through low cost building optimization systems—the most expensive active systems have the relatively least benefit. This led to a distinction of two approach levels. The basic level is benefits achieved through planning principles only. Given this, the first measure was the development of a housing typology, which allowed for a wide range of building standards and sizes: from single-family duplex units with private courtyards up to multi-family apartment buildings around large shared courtyards. Multiple variations for site adaptations and construction methods are possible with a modular space design using 1.5 m steps for unit width, starting from 6 m and ending at 15 m.

The introverted courtyard housing types in the modular scheme allow for private living in low rise high density:

- The main living areas are organized around a private courtyard, with solar light and warmth even in rear zones of the buildings.
- A separation of private and guest areas is possible as guestrooms are always accessed directly after entering the apartment/house without passing private zones.
- The shaded courtyards improve the micro-climate, especially in hot summertime.

2.6 Benefits

The benefits of the measures described above can be summarized as follows:

Urban Form

Climate-Sensitive Design

System of Hierarchy:

- Clear definition of public, semi-private, and private spaces and access systems.

Low-Rise—High-Density:

- Reduces heat loss,
- Shading effects,
- Free movement of air with a fresh, cool supply,
- Increased quality of green space,
- Reduced motorized transport,
- Reduction of sealed area.

Street Layout and Microclimate:

- Street layout helps to keep streets accessible even after earthquake hazard,

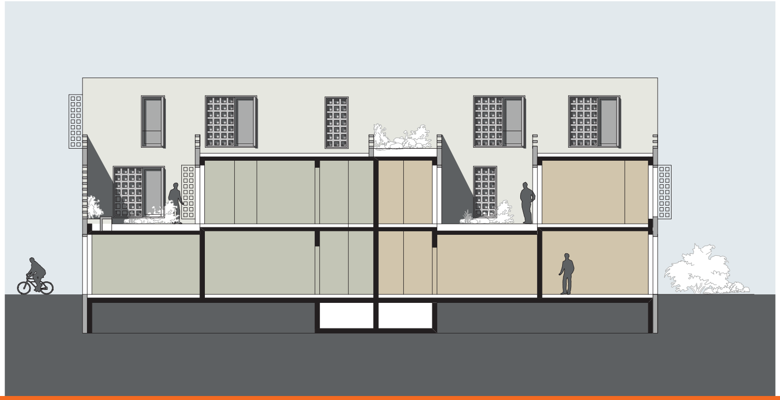


Fig. 110: Section through 9 m type residential building (Wehage 2013)

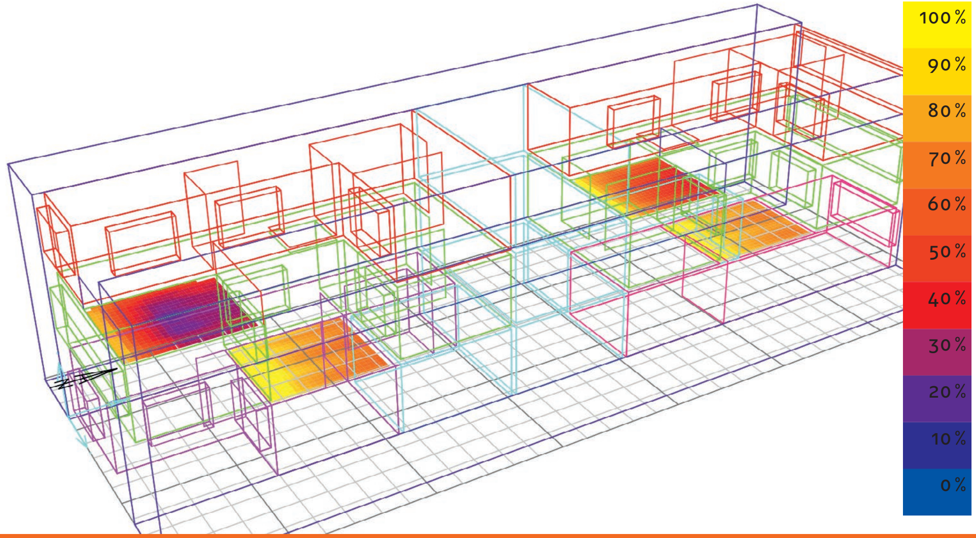


Fig. 111: Simulation of the opacity of courtyards in the buildings (Wehage and Pahl-Weber 2012, p.79)

2.5 Awareness Raising

The project dimension Awareness Raising hopes to make the environmentally friendly design attractive to residents and raise its local acceptance. A survey of Hashtgerd New Town's citizens' consumption patterns was taken, followed by a public exhibition about the plans of the pilot project area, in order to start an exchange with the inhabitants as a necessary prerequisite to successful implementation (cp. VI 9).

- Orientation/dimension of streets: east-west orientation of streets promotes the north and south solar exposure of the buildings, which can be more readily controlled as a result of the greater solar altitude (according to Givoni 1998, p. 368). Unfortunately, streets running north-south have better shading conditions in summer and better light conditions in winter. This is a conflict that can be solved by diagonal streets, orientated northeast-southwest (Ibid.),

- This street orientation allows for cooling and ventilation by afternoon and evening winds.

Topography and Site:
- Climate: harnessing cool winds for ventilation and cooling in summer by avoiding buildings in breezeways and by blocking hot winds with buildings and building groups,
- Optimized building orientation and form: buildings should not be blocked by other objects; location on a slope; south- or southwest-facing slopes are particularly suitable due to greater solar gain (Stadt Essen 2009, p. 5f.).
- Seismic hazards: Low rise building type reduces construction efforts and offers a larger variety of construction methods in seismic endangered areas

Extensive Landscaping

Provision of 7 m² quality green space per capita:
- Provides sufficient recreation area.

Green areas planted with adapted, low water consumption vegetation:
- Bind, and thereby decrease, atmospheric CO_2.

Small representative green areas with more water intensive plants and water saving irrigation systems:
- Reduced water demand results in reduction of need for pumping.

Eco-Mobility and Transportation

Soft Policy—mobility package with information and services:
- Informed inhabitants are more likely to change their habits and shift towards eco-mobility.

Hard Policies—public transport network including footpath, bicycle system, minibus-, citybus- and bus rapid transit-lines:
- Well developed public infrastructure reduces private motorized traffic and sealed areas for parking, remaining parking demand can be organized underground.

Urban Resources

Mixed Land-use Schemes

Mixed land use:
- Shorter travel distances reduce travel demand, which reduces fossil energy use.

Decentralized Mixed Use Schemes:
- Keeps motorized traffic out of the quarter; commercial uses around the plaza makes it a visible, lively center of the neighborhood.

Efficient Water and Wastewater Systems

Wastewater concept with decentralized constructed wetlands:
- Graywater used for irrigation of green areas; reduced energy use through reduced need for pumping; 70% of used water is kept in the water cycle.

Environmental Assessment

Environmental Impact Assessment:
- Reduces negative impacts such as soil sealing,
- Preserves existing valuable green structures,
- Creates supplementary green structures as compensation and recreational areas,
- Improves general environmental conditions, e.g. local climate issues, (as air quality, fresh/cool air supply, urban heat stress).

Urban Technologies

Energy Supply Systems

Improving existing systems and technologies:
- Low cost measurement (e.g. insulation of pipes) with improvements of up to 60%.

Use of New Technologies:
- Use of renewable energy sources, such as solar heat and ground temperature, as support for heating and cooling; using synergy effects of larger entities.

Regionally Adapted Architecture

Adaptation/Contemporary interpretation of regional traditional courtyard house:
- Local acceptance; offering privacy despite high density; maximizing energy impact through supplementary southern façades; using benefits of improved/controlled microclimate.

Urban Governance

Citizen Participation

Awareness Raising:
- Raising acceptance and attractiveness of project concept to habits towards climate friendly consumption patterns.

3 Steps and Measures for Energy-Efficient-Homes for the Shahre Javan Community

Annette Wolpert | Philipp Wehage

This chapter is based on the publication, "Energy-Efficient-Homes for the Shahre Javan Community" (Wehage, Wolpert and Pahl-Weber 2013), which addresses the need for "Energy-Efficient-Homes" against the background of fast growing societies. Here, the focus is on the different steps and measures of the housing development process, assigning them to four aspects, as outlined in Chapter III 2 and IV 2: Urban Form, Urban Resources, Urban Technologies, and Urban Governance.

3.1 Preconditions and Principles for the Design Process

In a fast growing society like Iran, efficient strategies for planning and construction processes are crucial to meeting the high demand for mass produced housing. In this regard, one of the best methods for the design of an energy-efficient home is a typological approach deriving directly from the planning process.

This "research by design" process is characterized by harmonizing general scientific principles (physical and technical) with local and regional conditions (climate and site). Energy-efficient housing in the New Town context in Iran calls for an analysis of the current urban design and architecture situation in Iran, and the potentials of vernacular architecture for future development in the semi-arid region. The energy efficiency value of the general architectural and urban findings are adjusted to each site's specific climate, topography, and socio-cultural context. The result of this research is formulated in a catalogue of architectural criteria as approaches for design solutions.

The data collection and analysis of preconditions for creating energy-efficient housing is characterized by general dimensions (e.g. general aspects for energy efficiency and volumetry) and specific dimensions (e.g. site and socio-cultural context). The influence of general and specific aspects affords the transferability of the results in a general dimension (e.g. energy efficiency through spatial design) and a specific dimension (e.g. climate and social adaptation).

Figure 113 shows the research by design process with the design and examination steps in a linear scheme. The final step shows the Conceptual Design for one urban unit in the pilot area as a standard definition and design solution for realization in the "Shahre Javan Community" context.

3.2 Definition of Framework Requirement

The development of housing design solutions is effected by four parametric groups: spatial, social, economic, and technical. These aspects serve as tools for assessment during the housing design process. Several parameters are part of multiple groups and should never be seen as isolated factors. The principals and preconditions for Energy-Efficient-Homes, discussed above, define these groups and are elaborated in more detail below:

Urban Form—Urban Design

The first parametric group describes the influence of urban design: To ensure continuity of the urban design criteria of the project pre-phase, the typologies must follow the urban morphology. In this, there is a distinction between "hard facts," such as the system of access as part of the mobility system, the technical infrastructure, the plot orientation, etc., and "soft facts," such as identity, flexibility, or the implementation of mixed use schemes—this is the "sensual" dimension of architecture.

Urban Resources—Sense of Place and Vernacular Architecture

The second group is derived from research on the vernacular architecture and local urban design. It reveals and embodies the socio-cultural dimension of architecture.

Urban Technologies—Energy Efficiency

The third parametric group defines aspects relevant to energy efficiency and can be deduced from the urban design, like the orientation of building volumes, which delineate the strategy at the building scale. The technical standard for energy efficiency, "high tech standard" or "low cost standard," for example, depends on local and regional circumstances.

Urban Governance—Users and Codes

The fourth group is characterized by the analysis of users and stakeholders. Requirements of this group, in both technical and spatial dimensions, include: building codes, technical principles, materials, the demand for energy efficiency, Iranian conditions, and urban design preconditions.

3.3 Analysis and Design Approach

Analyzing the preconditions and naming the requirements defines the framework of influence for architecture. Certain vagueness in the formulation (e.g. target group) can be replaced by assumptions or need to be integrated as they are to allow for flexibility in the final design. Thus a "research by design" strategy for developing housing typologies is site-specific and, in this case, is bound in application to the Shahre Javan Community site in Hashtgerd New Town. In the first step of this process, research on energy efficiency and the local urban design framework allowed for an analysis of the site's morphological and functional demands, which was then translated into a site-specific design strategy.

The goal of the strategy is to combine the advantages of two main aspects of energy efficiency in architecture and urban design: orientation and compactness. The second step was the development of site-specific strategies and measures for energy-efficient housing typologies by adjusting the morphological research with the parameter groups gathered in the analysis. The criteria identified in this step were then put into a catalogue to be made available as tool for evaluation, adaptation, and transferability for site-specific designs.

3.3.1 Energy-Efficient Housing for Compact Urban Form

The building volumes in the compact urban design scheme need to take advantage of their positioning. The plot design is based on a north-south orientation, determined in the urban design layout. This volumetric organization guaranteed a southerly orientation for every plot by keeping the compactness and reducing façade surfaces to west and east. Finally, the strategy of introducing "supplementary south-facing surfaces" via courtyards and niches harnessed two advantages: the energy savings by reducing the cooling and heating demand through the compact form and the energy gains through sunlight impact due to supplementary southerly façades (Hönger et al. 2009).

A criteria catalogue for energy-efficient housing typologies was gathered by examining the parameter groups of the initial analysis with regard to their morphological consequences (see IV 3). The criteria are as follows:

Urban Form

Definition of Access System and Urban Morphology

The typology must follow the urban design criteria, but needs to further develop the criteria on other scales in order to fully meet functionality and identity requirements.

Adaptation to Site and Topography

The typology is adaptable in regard to plot layouts and topographical specifics.

Potentials of Multi-Floor Courtyard-Houses

The typology includes introversion, as an expression of privacy for quality of life, and as a climate-friendly volume morphology in terms of light exposure.

Energy efficiency as Result of Architectural Design

Design as a strategy for energy efficiency: using an integrated design approach instead of isolated technological optimization.

Orientation of Volumes and Surfaces

Climate adaptation/optimization by adjusting building surfaces through architectural design (e.g. supplementary south orientated façades).

Urban Resources

Ground Floor as Potential Mixed Use Area

As a flexible-use provision, ground floors offer a potential space for a variety of commercial uses while maintaining residences on the upper levels.

Spatial Hierarchy, from Public to Private

Definition of spatial hierarchy with regard to the socio-cultural context. Achievement of design quality and its local acceptance by adapting to regional habits and traditions.

Urban Technologies

Application of Simple Constructions

Economic and ecological building construction, which considers the regional technological conditions. Design as step towards efficiency.

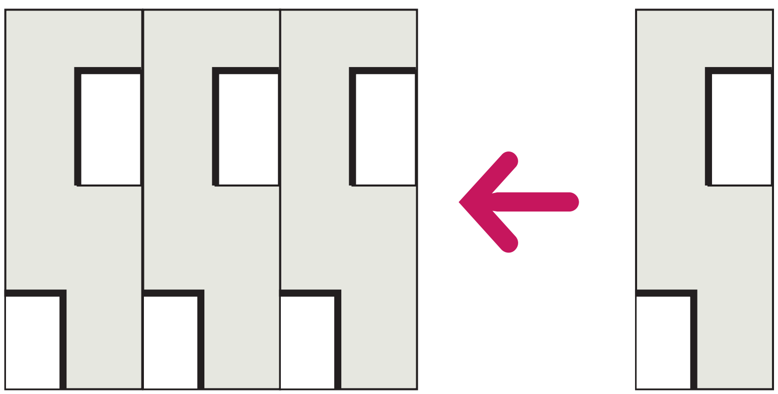


Fig. 112: Approach for energy-efficient housing in compact urban form (Wehage et al. 2013)

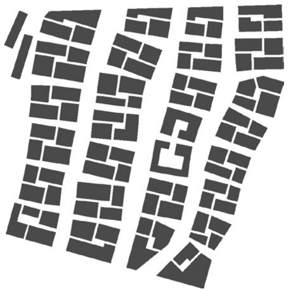
3.4 The Classification of Types

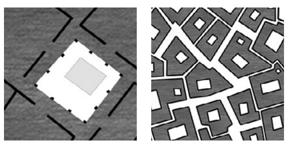
Considering the criteria for energy-efficient housing in the context of its application to the Shahre Javan Community led to design scenarios for a specific site in different steps and scales, and a modular spatial concept which influences the floor organization and construction principles.

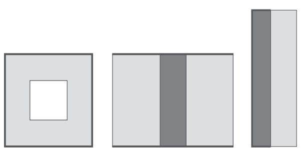
The first result of this modular space concept is the formulation of three basic building types, which, due to their large variety in unit sizes

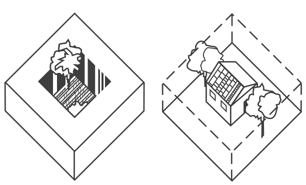
Input from analysis | **Parameter** | **Design approach** | **Criteria** | **Design concept** | **Design measures**

Input from analysis









Parameter

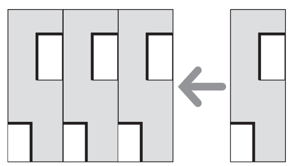
Urban design

Users and codes

Energy efficiency

Sense of place

Design approach



Criteria

Definition
of access system and urban morphology

Adaption
to site and topography

Ground Floor
with mixed-use potential

Spatial hierarchy
from public to private

Potentials
multi-floor courtyard house

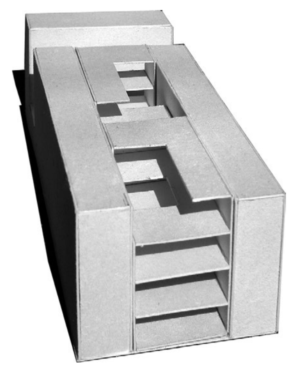
Orientation
Of volumes and surfaces

Application
Of simple constructions

Energy Efficiency
as a result the architectural design

Architectural concept
as an expression of identity

Design concept



Design measures

Orientation + dimension
- Optimize sun orientation through sculptural modelling
- Possible vertical organization of units in building volumes
- Closed coverage in an east/west direction
- Façade openings to exterior space in N and S

Organization + structure
- Modular space system as structural pre-condition for functional and constructive organization
- Vertical continuity for provision of economic and simple construction methods

Access + vertical connection
- Entrance from path
- Provision of additional entrance from garage
- Provision of central stairway inside the volume

From public to private
- Potential commercial unit and entrance hall on ground level accessed from path
- Semi private stairway
- Graduation of privacy inside unit through organization around courtyard

Variety + flexibility
- Horizontal organization for small units
- Vertical organization for big units
- Morphological variety through sculptural modelling of upper floors

Design study sub-neighborhood

Adaptive measures

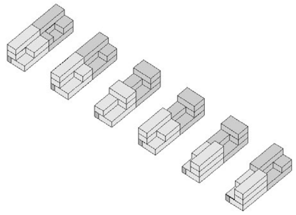
Site adaptation
- Choice of type
- Morphological variety through plot layout and dimension
- Morphological variety through sculptural modelling of building volume based on modular space structure

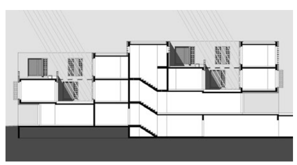
Functional adaptation
- Choice of type
- Access system
- Use (mixed use/housing)
- Vertical or horizontal floor organization
- Variety of floor plan layout

Standard adaptation
- Choice of type
- Construction and materials
- Façade structure and design
- Energy efficiency
- Supporting systems
- Interior arrangement and equipment

Energetic adaptation
- Choice of energy system
- Supportive, energy-efficient measures on an urban scale
- Supportive, energy-efficient measures on a building scale
- Construction and materials
- Technological input

Typological catalogue and design scenarios





Innovations

Basic principle

Courtyard house
Resource protection through building configuration

Modular space
Cost and energy efficiency through planning process

Upgrades

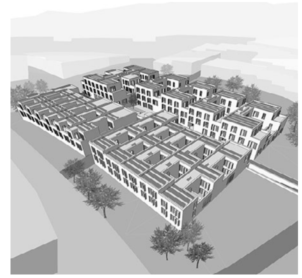
Sun shutters
Energy impact regulation through façade elements

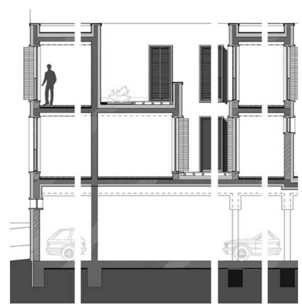
Light shelves
Energy gain through individual natural light and heat control

Photovoltaic fabric
Energy gain through individual control of natural light and heat

Geothermal energy and heat exchangers
Energy reduction through air-driven, combined heating-cooling-ventilation system

Design for urban unit





Conceptual design

Urban unit

Architectural plans
- Site adaptation to technological, functional and economical context
- Spatial organization of urban unit according to basic principle
- Spatial integration of innovative upgrades
- Spatial organization of floor plans and apartment layouts
- Preliminary plans concerning construction and materials
- Preliminary plans concerning construction and materials
- Visualization of spatial and physical qualities
- Integration of energy efficiency concept on an urban and building scale

Perspectives
- Basis for tendering and execution planning
- Basis for construction and detail research
- Basis for adaptation to other sites in the Shahre Javan community
- Basis for mitigation in a regional context

Fig. 113: Design process for Energy-Efficient-Homes (Wehage et al. 2013)

and housing styles, allow for adaptation to specific sites and regional conditions and therefore serve as the first adaptive measure.

The first step of the typological approach is carried out as a parallel process of analytic (top down) and synthetic (bottom up) classification. A modular space system, developed for introverted housing schemes in compact form, is an adaptive tool. Organizing and arranging spatial modules within the site volume while keeping standardized widths ("7.5-, 9-, 15 m types"), allows for a variety of floor organizations, sizes and designs. The various options, made possible by the typological catalogue, become a tool for creating identity at the building and urban scale and are an expression for the correlation between architecture and urban design. An evaluation of architectural qualities can be achieved by showing exemplarily variations of floor plan, sections, and views at the building. The main findings of the typological design process are:

Fig. 114: Private courtyard in an Energy-Efficient-Home (Pahl-Weber, Wehage and Wolpert 2011, p.111)

Urban Form

Orientation and Dimension

The urban form consists of long plots with north-south orientation. Volumetric shaping increases the number and size of southerly façades, creates private areas and improves microclimate conditions.

Organization and Structure

A structural system underlays the shaping strategy. A modular spatial system, with vertical continuity and low-rise (with a maximum of three stories) results in a simple, economic structural system and facilitates a high variety of floor organizations.

Access and vertical connection

House is accessible from the street and underground parking garages. Depending on housing type, the upper and lower levels are connected with a private or semi-private flight of stairs. Semi-private stairs can also work as a vertical air chimney.

Urban Resources

Public to Private

The ground floor's mixed use potential. The ground floor is the first step from public to semi-private through commercial unit or entrance hall, with the commercial unit and the entrance hallway as semi private areas. The stairwell marks the change from semi-privacy to the privacy of the apartment. The vertical organization of the area around the central courtyard also creates different degrees of privacy.

Urban Technologies

Variety and Flexibility

The structural system and the morphological concept both provide various layouts. The morphological adaptation allows for different unit sizes. The vertical continuity of structural and technical elements offers vertical combinations of space (e.g. duplex units). A sloped location can offer even more housing area/variety.

3.5 The Adaptive Typology

The scenario work for the "Shahre Javan" site reviews and evaluates the project aims and design results. The conceptual design, as the basis for execution planning, defines the final design solution for each urban unit in the "Shahre Javan Community". Re-transferring the first scenario to the general typological concept shows the potential of the architectural design approach. Moreover, a morphological study of all basic types shows how the many variations function as an adaptive tool providing flexibility in planning and execution, especially regarding functional and technical adaptation, as well as the integration of identity-forming aspects.

3.5.1 Fixed and Flexible Elements

Elements, components, and standards, with technical, construction-based, and sensual characteristics, guarantee functionality and are the basis of this typology. While modifications and adjustments to specific sites and functions are adaptations to "fixed" characteristics, flexibility in the typology is required by the planning process. The modular space system serves as framework for construction and organization of the housing units (fixed). On the other hand, the modular framework enables the organization of private zones and service zones in different floor layouts (flexible). The vertical continuity of the structure offers constructive and technical functionality (fixed). The arrangement of the space modules in building morphologies on different plot layouts aims for functionality, privacy, and energy efficiency in a specific urban context (flexible).

Identifying fixed and flexible elements enables the formulation of adaptive strategies, which allow for transfer of research and planning results, as well as specification of elements for creating architectural and urban identity and variety. The strategies for adaptation are classified in different layers of architectural design:

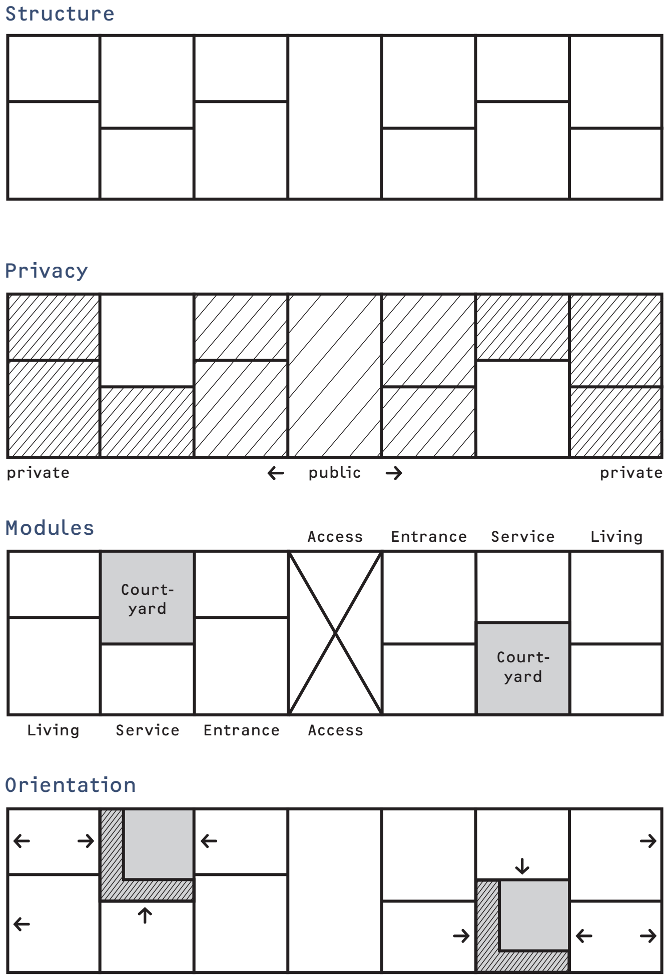


Fig. 115: The structure of Energy-Efficient-Homes (Wehage et al. 2013)

Urban Form
- Morphology—as a volumetric adaptation in the urban context

Urban Resource
- Floor organization—as a functional and spatial adaptation for the single building

Urban Technologies
- Passive and Active Energy Measures—as spatial and technical design measures for energy adaptations
- Appearance and Construction—as design and structural measures for adapting to social and economic standards

3.5.2 Strategy for Site Adaptation

The design approach of the housing typology respects the urban design concept as a spatial determination within which buildings must fit. Thus, every building is a specific unit of a bigger spatial arrangement.

Due to this situation, the design concept of the building must offer suitable adaptive tools. The developed modular space scheme allows for morphological adaptations to the specific site.

- *Length*—the length of the house depends on the plot size;
- Courtyard Layout—depending on plot size, the courtyard is enclosed on two or three sides;
- *Number of Courtyards*—depending on plot size, a second courtyard can be introduced;
- *Orientation*—influences solar incidence, privacy, and identity (see Fig. 115).

3.5.3 Strategy for Functional Adaptation

For functional reasons, the typology must offer flexibility in use. The focus on flexibility is determined by the following measures:

- *Type of staircase*—a staircase for two units or a staircase inside private units;
- *Mixed use*—commercial unit on ground floor, making the building mixed use. The commercial unit can be part of the upper apartment or independent;
- *Horizontal/vertical layout*—units can be organized horizontally or vertically;
- *Unit size and number of units*—number of units per plot can vary, depending on plot size and unit sizes;
- Apartment layout—the possibility of open and closed apartment layouts (including kitchens).

To summarize: the floor organization is flexible to individual needs at the unit scale, and the flexibility of unit size and layout is a suitable tool for housing market requirements.

3.5.3 Strategy for Energy-Based Adaptation

Beyond achieving energy efficiency through building configuration, optimization can be achieved through additional measures. Renewable resources, such as sunlight and ground temperature, can be used by applying simple constructions.

- Configuration/compactness reduces heat loss in winter and helps to avoid overheating in summer. Furthermore, the north-south orientation captures intense solar radiation from the south and avoids the east and west sun in summer, which is more complicated to control;
- Light-shelves in the courtyards (see Fig. 118) shade the courtyards in summer and in winter they help to lighten the front and back of the yard equally;
- Photovoltaic fabric can cover yard in summer to provide shading, simultaneously producing energy that can be used in the evening. In winter it can be pushed out of the way;

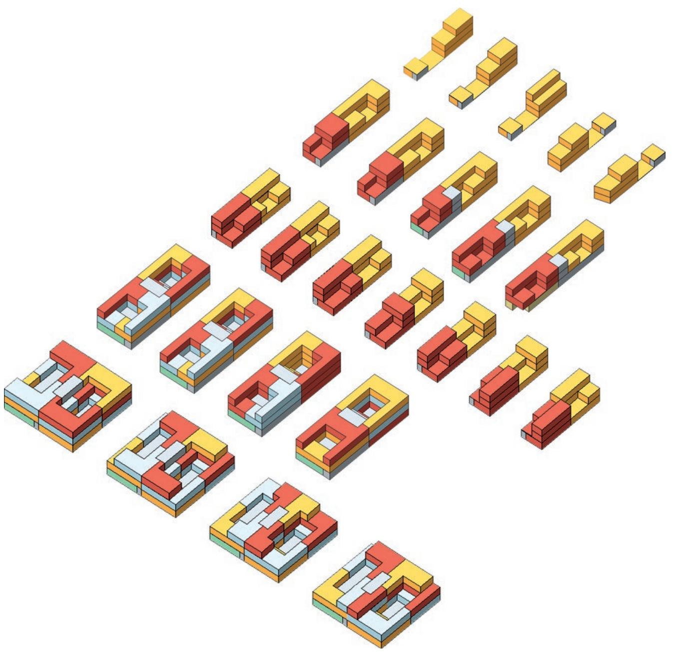


Fig. 116: Typology catalogue (Wehage et al. 2013)

- A heat exchanger, installed at the building level, recovers the otherwise "lost" energy of exhaust air;
- A heat exchanger, installed at the sub-neighborhood-level (see Fig. 117), uses constant soil-temperature from 1.5–4 m depth to precondition the supply/outside air.

3.5.4 Strategy for Identity

Other than the morphological arrangement, as a strategy for energy-efficient identity on urban scale (see Fig. 119), the design of the façades determines the appearance of the buildings. The structural method, floor-organization, floor-formation, and architectural design of the apertures characterize the buildings' façade. The aperture typology is influenced

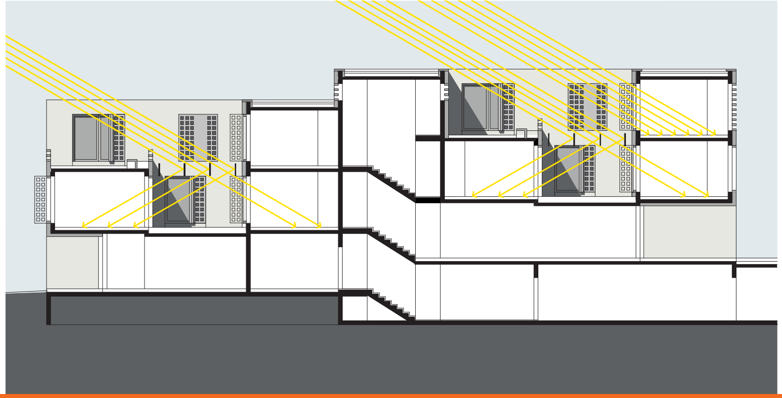


Fig. 117: Earth tube system in urban unit (Wehage et al. 2013)
Fig. 118: Lights-shelves (louvres) in winter position (Wehage et al. 2013)

by the importance of the façade's role in energy impact, or solar incidence. Indeed, south-orientated façades are highly relevant for passive energy impact and the design of the façades' apertures is a very important tool for energy efficiency. The closed coverage and compact morphological arrangement initially reduces the surface area of the façades to a minimum. The southerly façades of the single units, orientated towards the street, courtyards, and open spaces, are responsible for much of the sunlight, which reaches the living rooms. Therefore, the southerly façades should have a high share of apertures (see Fig. 119).

The positioning and dimensioning of openings will need to balance energy efficiency with privacy, within the confines of the "Shahre Javan Community" urban concept.

As a measure for privacy:

- *Layout of aperture (fixed measure)*—high and narrow aperture (room-high);
- *Position of aperture (fixed measure)*—shifting the arrangement in opposite façades;
- *Sun-shutter (flexible measure)*—can shield the rooms from outside eyes.

As a measure for energy efficiency:

- Façade as non-bearing wall (fixed measure)– flexible arrangement of façade elements e.g. windows are pushed in, self-shading through "overhang" due to wall-thickness;
- Sun-shutters (flexible measure)—can be open in winter to maximize solar incidence and closed in summer to prevent overheating.

The modular spatial system of the building typology allows for a variety of construction methods. A simple structural system consists of:

- Plot types are 6 to 15 m in 1.5 m steps, maximum structural span is 7.5 m;
- The depth of the building structure is adaptable to the plot layout by adding spatial modules in the north and south. Buildings are always ending at the building line designated in the detailed plan;
- Vertical continuity;
- Low-rise with a maximum of three stories.

Simple structures allow for different structural systems:

- Pre-fabrication;
- In-situ-construction methods;
- Combined solution with semi-precast-elements;
- Low-rise with a maximum of three stories.

Systems depend on: site conditions, traditional building methods and the education of workers, availability of materials, and the budget. The same applies for the spectrum of possible construction material. A frame mode construction of concrete can be combined with light wall materials or bricks. The choice of the remaining façade materials (e.g. bricks) can follow environmental as well as economic aspects. For the Energy-Efficient-Homes in the Hashtgerd New Town pilot project area, a concrete framework with concrete bracing walls inside the unit was chosen as the structural system, with ETICS as the thermal envelope of the building.

3.6 Basic Principle and Upgrading

The result of the design process for adaptive measures of the Energy-Efficient-Home housing typology combined with the identification of the urban, architectural, and technical elements led to the definition of a basic principle and possible upgrades. The Basic Principle is the design strategy for energy-efficient architecture and urban design derived from a spatial approach without any additional technical demand. It contains all planning and design measures to advance energy efficiency with only spatial configuration, such as building orientation and compactness, adapted to site and cultural context. The Upgrading contains all measures for raising the standard of the Basic Principle. Supplementary technologies can be integrated into the spatial approach. The choice of upgrading measures is dependent on the economic and technological context.

3.7 The Conceptual Design

The findings of the design and research process for Energy-Efficient-Homes are transferred to a final design proposal for an urban unit in the Shahre Javan Community pilot project. Via a specific design scenario of the architectural and urban design concept and its adaptive measures, developed from the typological approach, the challenges of application can be weighed and evaluated. Furthermore, the realistic scenario serves as a basis for cost estimates, energy simulations, and the detailing of construction. A spatial organization in 1:100 scale together with sample detailing of the architecture in the Shahre Javan Community in 1:20 scale can help define the standard for materials and energy goals.

Fig. 119: Study for different south façades of 7.5 m building type (Wehage et al. 2013)

Fig. 120: Areal of urban unit from the southeast (Wehage et al. 2013)

A sample sub-neighborhood in the center of the pilot area is located on a ridge, with access from the collecting road coming from the eastern valley and edged by the central public green on the western valley. Following the determinations of the “Tarh-e-Tafsili” (detailed plan), developed at TU Berlin in the Urban Planning and Design Dimension, the urban outline and the inner access structure were both fixed in the placement of building lines. Parking is provided below the building development, with access from the collection road. The inner access paths are mostly for pedestrians, the only motorized traffic allowed is for supply and emergency situations. The paths structure the unit into four building plots. A small urban square, positioned at the crossing of the access paths, is the social and spatial center of the urban unit.

The density of building plots is estimated with a floor area ratio of 1.7–2.0. The range in apartment sizes was estimated to be 75–200 m² for at least 75% of the housing units. A possible replacement of different housing types enables flexibility. For example, to gain more variety, the seven 7.5 m unit types on building plot C can be replaced by six 9 m types, fitting within the same building outline.

With the help of the typological approach, the Conceptual Design for Energy-Efficient-Homes illustrates the strategies for adaption at different levels and scales. Within the determinations of the detailed plan (Tarh-e-Tafsili), adaption is achieved by:

At the urban scale:
- Choice of typology and its position as a functional adaptation;
- Shaping and organizing the building volume, such as the planning of forecourts for the entrances and the tiering of floor volumes, act as morphological adaptations.

At the building scale:
- Floor organization, such as the arrangement of private and guest zones and the tiering of upper levels for better light incidence in the courtyards, act as morphological and functional adaptations.

At a detailed level:
- Adapting façade design to site context, for example, through integrating sun-shutters;
- Provision of system-relevant elements, such as a necessary common utilities underneath the central square and earth tubes at the parking level;
- Choice of materials with respect to site conditions, availability, required standards, energy goals, and economic factors, e.g. in choosing the thermal envelope and construction method.

3.8 Perspectives

A spatial strategy, which considers energy relevant aspects of urban and architectural morphology within a specific social context, results in a practicable basic energy standard concept, which is adapted to the region. The courtyard housing scheme of the Energy-Efficient-Homes, described here, represents a new development borne of the background of vernacular architecture.

Because of its high degree of variability in unit number and size as well as morphological adaptation, the typology can be easily transferred to other sites in the region. The developed housing scheme, based on Islamic tradition, offers culturally adapted energy-efficient housing for the Middle East. The energy relevant advantages of the compact urban form and its building configurations could create higher spatial quality for New Towns as the concentrated building volumes create clearly defined open spaces with public relevance. Moreover, the simple, basic layout and structure of the introverted, individually regulated housing units responds to the specific technical and economic conditions of the region.

4 Low Carbon Energy Systems for the Shahre Javan Community

Jörg Huber | Christoph Nytsch-Geusen | Tim Schünemann

One of the project goals is the development and design of energy-efficient buildings and energy supply systems for new Towns in Iran. In this regard, five different energy concepts for residential heating and cooling were developed, in light of the master plan, and compared. These different energy saving systems are:

1. A reference system: A conventional Iranian energy supply system for residential buildings at the building level (de-central system);
2. An improved Iranian system: An improved cooling technology and a modified heating system with solar thermal collectors and condensing technologies at the building level (de-central system);
3. A compression cooling system with solar electricity and improved heating system at the building level (de-central system).

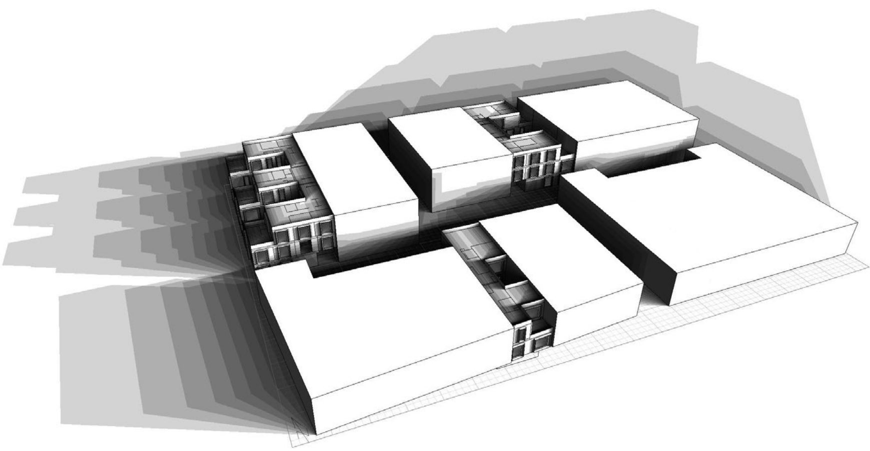


Fig. 121: Thermal building model of one of the Shahre Javan Community sub-neighborhoods

4. A semi-central system with a thermal driven cooling system and a co-generation plant for the heating and electricity at the sub-neighborhood level.
5. Central heat generation with a co-generation plant in the Shahre Javan Community pilot area and semi-central thermal driven cooling system at the sub-neighborhood level

4.1 Energy Demand Analysis

A detailed energy demand analysis for each building was very important for the design of energy infrastructure systems for the Shahre Javan Community pilot area. The analysis considers building physics and the energy efficiency of the buildings in detail as well as calculates the chronological sequence of average zonal values (e.g. air temperature, heating load, cooling load) for a significant period of time (e.g. over the summer). The results are shown in Figure 121.

Further, various operating modes for ventilation, heating, or cooling are also analyzed. The interaction of the façade (external thermal loads), the ventilation (natural/mechanical), the internal thermal loads (occupants, lightening, etc.), and the thermal storage capacity of different building elements are all considered. The calculation results are carried out using hourly data from an entire year.

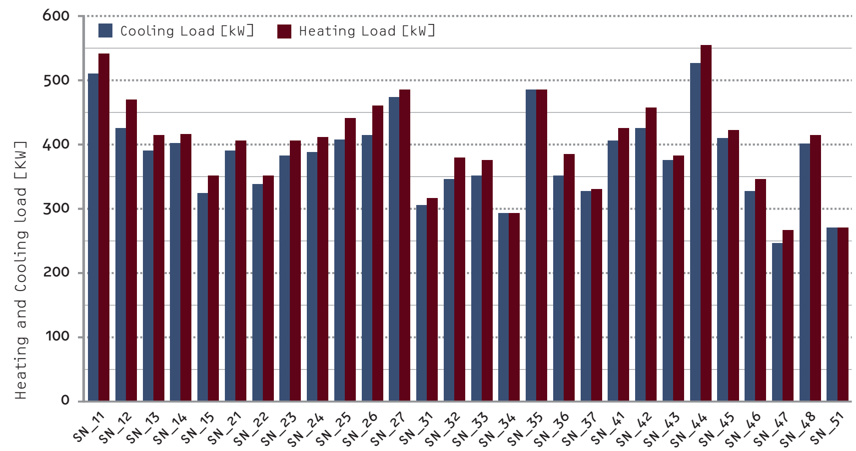


Fig. 122: Comparison of heating and cooling loads of Shahre Javan Community sub-neighborhoods

The energy load for the Shahre Javan Community area includes the load of all buildings (residential and other). The overall load is 11.3 MW (33.6 W/m²) for heating and 10.7 MW (31.8 W/m²) for cooling. Figure 122 shows the different heating and cooling loads for each sub-neighborhood.

4.2 Energy Supply System Options

Based on the energy demand analysis described above, four different energy-efficient energy supply systems were designed and then compared with each other, using a conventional Iranian energy supply system as reference, in regard to each system's primary energy demand, carbon dioxide emissions, and life cycle energy costs. The low-end reference system calculation consists of a residential building with envelope and energy efficiency equal to the current Iranian energy code (Code 19) (see System 0.1 below). A high-end reference calculation was made with a building with an enhanced building envelope and higher energy efficiency (see System 0.2 below). The calculations for the developed energy supply systems are based on the improved building envelope.

System 0.1 and 0.2: Conventional Iranian energy supply system for residential buildings (de-central system at the building level)

This reference system represents the widely-used Iranian energy supply system for residential buildings in hot and dry climate regions. Here, the hot water demand is met with a central natural gas-boiler (without condensing technology) in the basement.

All components of the heating system are almost entirely un-insulated and the heat is transferred by convectors into the rooms. For space cooling during the summer, an evaporation chiller for each unit is installed on the roof of the building. This chiller uses condensing enthalpy to produce cold air, which is distributed through a single duct system with up to 25 air changes per hour in the respective zones. An exhaust duct system DoEs not exist and the waste air is discharged through leaks, gaps, or open windows. Due to the high air exchange rates and the desired low air temperatures in summer, the water and electricity demand of the evaporation chiller is enormous.

System 1: Improved Iranian cooling technology and modified heating system with solar thermal collectors and condensing technologies (de-central system on the building level)

The improved Iranian cooling system is an extension of the conventional Iranian system with a few additional components. With these extensions and new components the energy and water consumption can be dramatically reduced. Furthermore, all components of the heating system (thermal storage, distribution pipes, etc.) were covered with insulation for a significant reduction of the thermal losses. In addition, thermal solar collectors were installed on the roof of the building; the solar energy is primarily used for domestic hot water supply and also as partial support for the heating system.

This system is an extension of the conventional Iranian system by a few components (heat recovery and second air duct). The production, distribution, and transfer take place at the building level (cold on the roof, heat in the basement and on the roof of the building).

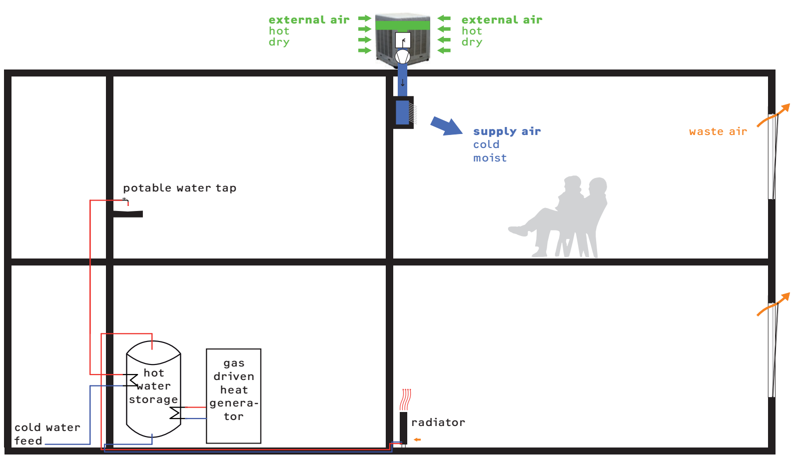


Fig. 123: Energy plant system of the conventional Iranian system for heating and cooling

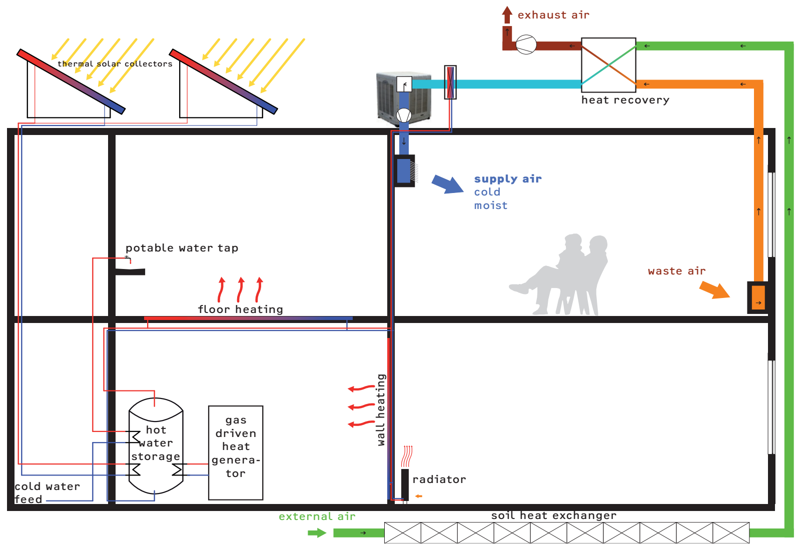


Fig. 124: Energy plant system of the improved Iranian system for heating and cooling

System 2: Compression cooling system with solar electricity and improved heating system (de-central system at the building level)

The conventional adiabatic evaporative air cooling system is replaced with a cold water supply system. Here, the electricity needed for the compression chiller is produced by photovoltaic modules. If an over-production of electricity occurs, it can be fed into the grid. A cooling tower would increase the COP (coefficient of performance) of the compression but would, however, increase the demand for water. Given the water-scarcity of the project region, use of a re-cooling tower should be discouraged. The heating and hot water system is the same as described in the improved Iranian system.

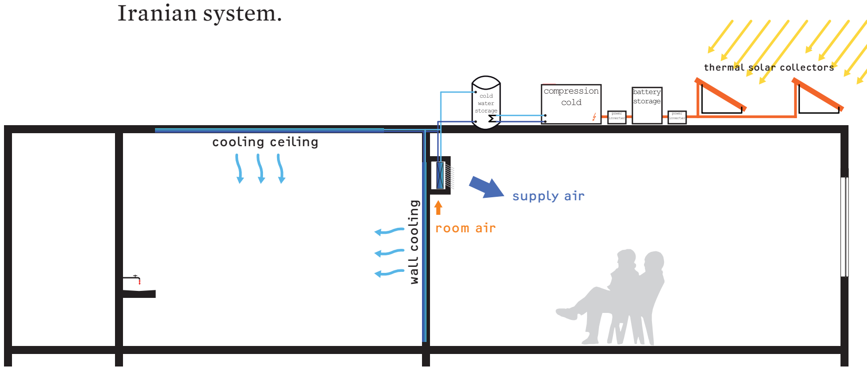


Fig. 125: Photovoltaic cooling system and improved heating system at the building level (de-central system)
Fig. 126: Semi-central energy production

System 3: Semi-central system with a thermal driven cooling system and a co-generation plant for heating and electricity at the sub-neighborhood level

The technology used for cooling buildings is an absorption chiller which converts heat into cold and supplies a whole sub-neighborhood. The heat comes from thermal solar collector fields on the roofs of the building. If the collectors have a limited heat gain, the co-generation plant for the whole sub-neighborhood produces additional thermal energy. Due to the central cold water storage, a chiller for the peak cooling demand is unnecessary. Every absorption chiller needs a recooling unit, most of which are designed as wet-cooling towers, which require a considerable amount of water.

*System 4: **Central heat generation with a co-generation plant in the Shahre Javan Community pilot area and semi-central thermal driven cooling system at the sub-neighborhood level***

This central system is very similar to the previous system, but the heat production (if there is a undersupply by the thermal collectors) is centralized for the entire Shahre Javan Community. The cold production is identical to the system in each sub-neighborhood with an absorption chiller system.

4.3 Analysis Results

Each of these energy concepts have been analyzed for their energy demand, life-cycle cost, and CO_2 emissions. The investment costs and primary energy factors are calculated with German values. These European prices were reduced to match the economic situation in Iran using regional factors (from "BKI Baukosteninformationszentrum" [BKI_Baukosten]). Because of the unknown Iranian primary energy factors, the German values were retained for the comparison.

	System	Overall costs, (Iran) [€/m²a]	CO_2 emissions [kg/m²a]	Primary energy demand [kWh/(m²a)]	Water demand for cooling [kg/(m²a)]
0.1	Reference System, Code 19	15.5	47.6	288.2	371.0
0.2	Reference System, Young Cities	10.8	30.7	179.8	341.9
1	De-Central System 1,	6.8	13.2	79.1	66.0
1	De-Central System 2	4.7	4.8	34.9	0.0
3	Semi-Central System	8.5	13.9	89.8	10.8
4	Central System	8.0	12.9	84.0	10.8

Tab. 8: System comparison

4.4 Recommendation

Based on the analysis the recommended system is the "Improved Iranian cooling technology and modified heating system" (System 1). The components of this system are nearly all available or producible in Iran and the technologies used are known in Iran. The facts of the recommended system are:

- Cooling: Improvement of a commonly used air conditioning technology in Iran (an additional air duct, a further ventilator, and a heat recovery unit for each flat);
- Heating and hot water generation: Use of technologies used worldwide for condensing boilers and solar thermal systems. There are excellent possibilities for implementation at the single building level;
- Resources saving potential (against Code 19): primary energy savings of 66% and water demand reduction of 81% (see Fig. 127);
- Costs: Moderate investment costs and low life cycle energy costs (see Fig. 128);
- CO_2 reduction (against Code 19): All of the different systems reduce CO_2 emissions dramatically (see Fig. 128).

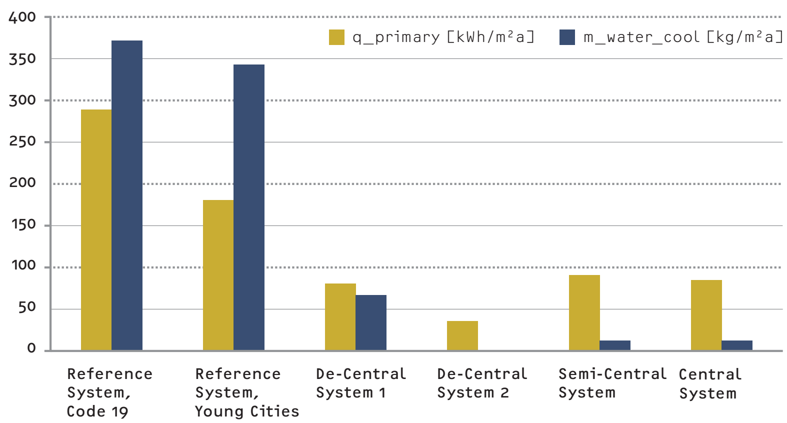


Fig. 127: Primary energy and water demand of the energy supply systems

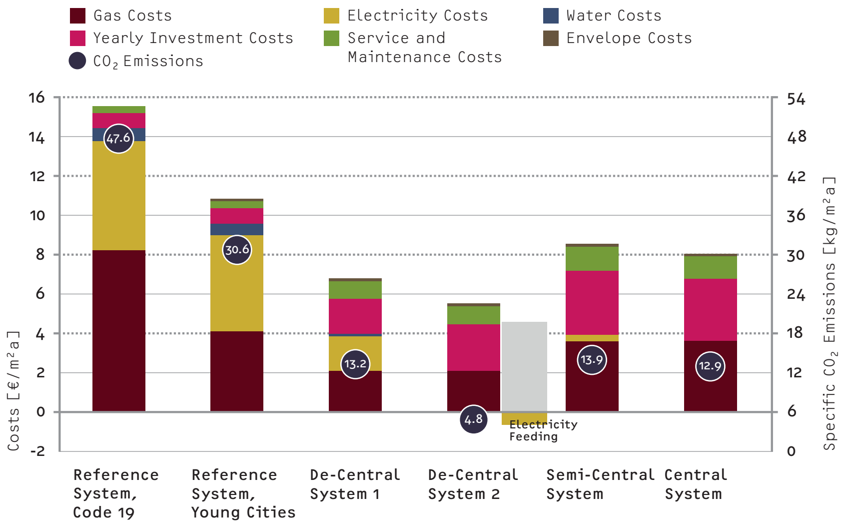


Fig. 128: Cost comparison of the energy supply systems based on Iranian costs

5 Sustainable Water and Wastewater Management for the Tehran-Karaj Region and the Shahre Javan Community

Tamara Nuñez von Voigt | Shahrooz Mohajeri | Johannes Sauer | Martin Vocks

To develop sustainable solutions for water management challenges in Hashtgerd New Town and the Tehran-Karaj region was not only a major effort, it is of crucial importance for successful future development. The modern and integrated concepts and technologies described in Chapter III 5 are necessary for protecting the scarce water resources of the region and reusing wastewater as a new resource. Therefore the goal of this project was to identify possibilities to reduce water consumption while taking into account the specific socio-cultural, economical, technical, and legal conditions. In an effort to reach this goal, project participants developed water-saving concepts for water demand management and wastewater management for arid to semi-arid regions and tested their effectiveness in pilot projects.

5.1 Water Consumption Patterns and Strategies of Reducing Household Water Consumption

In order to gain a basic understanding of water consumption in the Tehran-Karaj region, the water use of three sample households was monitored for five weeks from July through September of 2011. Although not a complete sample, the water use of these households made some trends clear (see Table 9). One of the biggest water consumers in Tehran households are water-cooled air conditioners (see Fig. 129). The air conditioner alone consumes up to 300 l/d when working around the clock on a hot day. This water evaporates—it is not discharged through the wastewater system and, therefore, cannot be reused. Replacing these popular devices would create huge water savings, merely turning off an air conditioner when leaving the apartment would save more than two-thirds of this water use (see household 2 in Table 9). Without air conditioners,

Household	**1**	**2**	**3**
Number of residents	1	4	6
Age of the residents	75	54; 47; 23; 21	75; 62; 42; 37; 13; 13
Total consumption [m³] (five weeks, 30/07–03/09/2011)	11.4	19.7	33.9
Average Daily consumption [l]	315.9	546.9	941.9
Average Daily consumption per Capita [l]	315.9	136.7	157.0
Minimum Daily consumption [l]	84.0	173.7	477.2
Minimum Daily consumption per Capita [l]	84.0	43.4	79.6
Highest Daily Consumption [l]	1,092.9	1,154.2	2,066.1
Highest Daily Consumption per Capita [l]	1,092.9	288.6	344.4
Air Conditioner (AC) Total consumption [m3]	6.3	1.9	7.5
Without AC: Total consumption [m3]	5.1	17.8	26.4
Without AC: Average Daily consumption per Capita [l]	142.5	123.7	122.4

Tab. 9: Water consumption in sample households (inter 3 GmbH; own measurements)

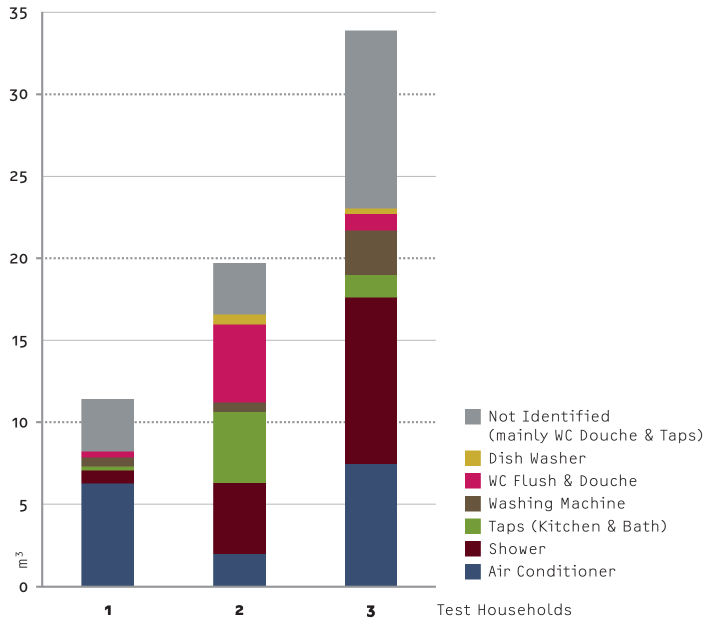


Fig. 129: Water consumption patterns in sample Tehran households (inter 3 GmbH)

the per capita water consumption is about 130 l/d/p—much lower than the figure assumed by the Tehran Water & Wastewater Companies. Showers also play a big part in water consumption. End-use measurements show that the biggest savings potential for showers lies in reducing shower times, especially since flow rates are already low. Water consumption by washing machines differs dramatically by the production year. A 30 year old machine needed about 100 l per wash, while a ten year old machine needed only about 50 l. In this instance, water companies could develop incentives for households to save water by replacing old machines.

5.2 Reducing Unaccounted-for-Water

One focus of this project was the evaluation of current water loss levels in the water distribution network of Tehran, determining the different loss components (physical vs. apparent losses), and then developing and implementing a tailor-made loss reduction strategy. This process was carried out in a pilot area in the north-eastern part of Tehran selected and established as part of the project.

During the project, several onsite visits and meetings were held with the Tehran network counterpart to assess the situation and help the counterpart in making decisions as well as to jointly discuss and analyze the results.

Directly after establishing the pilot area it became clear that some basic conditions and factors important for successfully starting the project were not met. The counterpart lacked a systematic step-by-step approach for establishing a pilot zone and Districted Metered Areas (DMA) and did not have the resources for carrying out the necessary measurement campaigns within its boundaries. The know-how and human capital established during previous, similar projects which had been jointly carried out with the network operator had, apparently, been lost in the intervening years due to organizational restructuring and insufficient human resource management.

Therefore, the main focus of the project shifted towards putting the necessary fundamentals in place to ensure that all data collected within the project were valid and based on sound data collection and analysis methodology.

The key components were:

- Carrying out DMA isolation tests—thus ensuring that no flows cross DMA boundaries without being measured;
- Analyzing and preparing the customer database—this ensures that all customers within the DMA are correctly recorded and that the customer database matches the DMA boundaries;
- Updating network maps, analyzing the network structure and the pipe damage statistics to identify “hot spots” for loss reduction;
- Improving & fixing the main inflow flow meter, which showed several deficiencies, to ensure that all inflow data collected is continuous and accurate;
- Relocation of pressure sensors inside the zone—for better and more representative pressure monitoring;
- Putting online flow meters on the biggest customers—to ensure that minimum nightflow measurements are correctly carried out.

These fundamental steps had to be repeatedly carried out to familiarize the counterpart with this DMA approach, a standard according to World Bank and IWWA methodology. As this exercise took much of 2012, the remaining project time was focused on establishing the water balance and proposing a water loss reduction strategy. The results of establishing a water balance can be summarized as follows:

- Physical water losses for the DMA are about 17–19% of total input;
- These high losses are mostly due to the relatively high pressure in the network combined with certain pipes (PE-110mm) that were incorrectly laid about 20 years ago;
- An improved pressure management could substantially reduce these losses—however this requires a partial restructuring of the whole network;
- A water meter audit showed that apparent losses due to inaccurate or damaged customer flow meters are only a few percentage points of total input—the network operator has already implemented an effective water meter management strategy;
- Total water losses are in the range of 20–25%—within the range given by the operator for the whole network of Tehran.

Clearly, the main recommendation for water loss reduction is the establishment of a better network pressure management by re-zoning the pressure zones and ensuring good quality control for pipe construction work. Water loss monitoring should be established in all of Tehran and the available leak detection capabilities and capacities have to be increased—in part by “insourcing” some of these crucial services back to the network operator.

In summary, the counterpart is aware of the need for comprehensive water loss monitoring based on the DMA-approach as developed by World Bank and IWWA. In general, the network of Tehran allows for relatively easy implementation, as it is already divided into multiple sectors and the operator has established functional operating entities and departments.

However the operator still lacks both a systematic approach and sufficiently trained staff to carry out this task. Further, the question of available resources is a larger issue for Iran at present and it remains to be seen whether a comprehensive water loss monitoring and prevention program can be implemented in the near future.

5.3 Wastewater Management

The wastewater concept for the Shahre Javan Community pilot area follows a modern strategy. Black- and graywater are collected separately within the household. Graywater is treated and reused on site while blackwater is transported to a wastewater treatment plant for purification. A more comprehensive system with separate collection of the different wastewater components yellowwater (urine), brownwater (faeces) and graywater (bath and kitchen wastewater) is not feasible in view of the cultural setting. Furthermore, the necessary infrastructure for treating and using urine and faeces is not considered realizable in the short term for Hashtgerd.

Still, the concept offers prospects for the efficient use of resources and innovative wastewater infrastructures, which allow more flexibility for future growth.

5.3.1 Graywater Treatment and Reuse

The concept for the pilot area consists of a separate collection system for graywater which includes water from bathtubs, showers, sinks, and washing machines. The kitchen water will be collected separately since it contains high concentrations of fat, organics, and solids which complicate the treatment requirements.

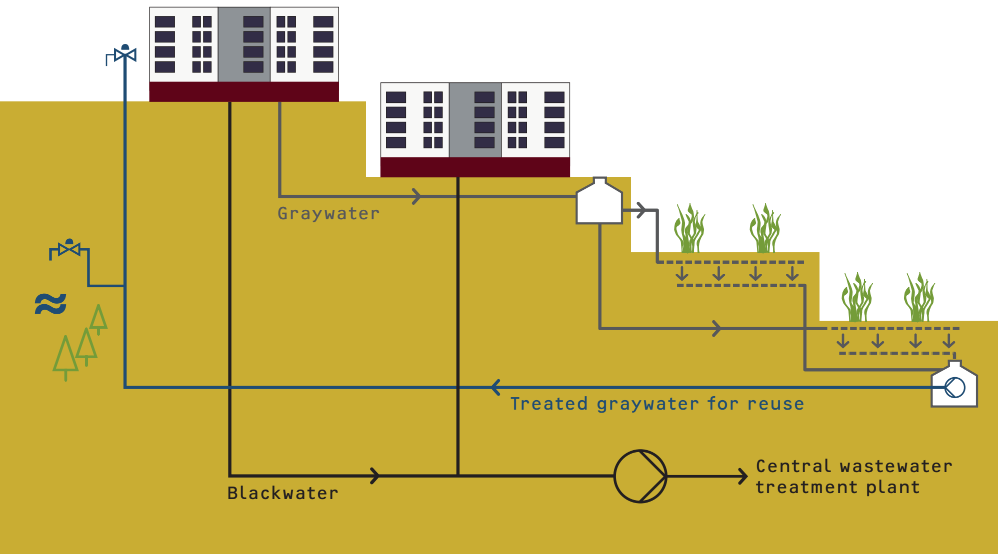


Fig. 130: Wastewater system for the Shahre Javan Community (p2m berlin GmbH)

Graywater treatment

Decentralized constructed wetlands are intended for the treatment of graywater. Constructed wetlands (CWs) provide a robust and well developed low-tech solution with a minimum demand for maintenance and produce a high quality effluent which can be reused directly for non-in-house purposes. Pre-treatment is therefore not necessary since, without kitchen water, graywater contains low solid concentrations.

The use of vertical flow type wetlands can reduce the necessary surface of the CWs. These CWs should be operated intermittently. As shown in Figure 130, the distribution tank will include several chambers. To create an intermittent flow, a siphon installation is mounted within the chambers. The water rises to a maximum level and is then sucked out of the chamber down to an adjustable minimum level by the siphon effect. Such an installation requires no pumping, which reduces energy and maintenance demands.

The principle behind CWs' soil filter process is explained in detail in chapter III 5. Special plants are grown within the filter, and their roots keep the soil filter porous. Typically, reed-type plants are used in CWs. Bacteria in the soil filter carry out the wastewater treatment. Several other types of plants with more attractive blossoms than reed have proved successful in coping with the conditions of a CW, and the hot, dry local climate. This includes Iris and Canna plants.

According to recent publications, the treatment efficiency of graywater in CWs is excellent. Up to 99% of surfactants found in graywater are removed. Untreated graywater contains between ten and 105 cfu/100 ml of coliform bacteria and E. Coli. CWs therefore produce an effluent which fulfills the hygienic standards of the EU bathing water directive.

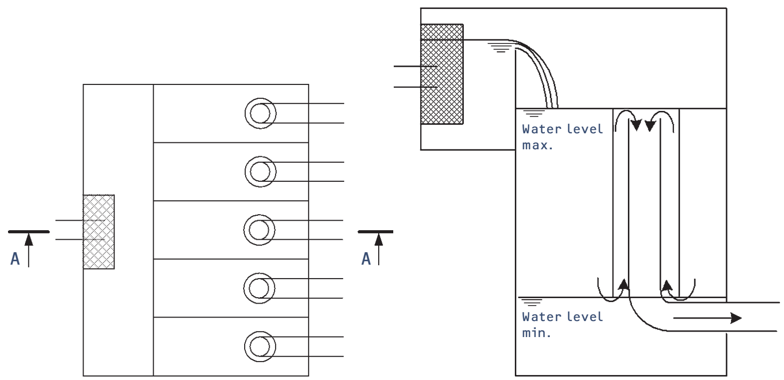


Fig. 131: Schematic of the collection and distribution system of the graywater (p2m berlin GmbH)

Considering the low pollutant content of graywater and the choice of vertical flow type CWs; a design value of $1\,m^2$ CW surface/inhabitant was selected. This value is based on calculations made according to German standard methods (DWA) and was also proven to be sufficient in other cases (Frank 2005).

The design value of 1 m²/inhabitant is based on the nutrient load of the wastewater, a factor which is dependant on the number of inhabitants. Therefore an increase or decrease of water consumption which leads to a change in the concentration of nutrients, but not to a change in the daily load, will not impact the treatment performance.

The CWs will be placed close to residences in order to keep the pipe network as short as possible. Fig. 132: shows the placement and required 8,000 m² surface area. The olive areas on the map mark the locations of possible constructed wetland areas. Integrating graywater treatment within the urban landscape is possible given that the graywater DoEs not give rise to visual, odor, or hygienic issues of the kind generated by kitchen wastewater.

Fig. 132: Distribution of the CWs (olive) over the Shahre Javan Community pilot area (p2m berlin GmbH)

Graywater reuse

Reuse of graywater will reduce the potable water demand. After treatment in constructed wetlands, graywater is of a quality which is sufficient for replacing potable water in the following applications:

- Irrigation of green spaces and trees;
- Supply for artificial water bodies;
- Service water.

Green spaces and trees will be spread over the whole area and irrigation should reuse treated graywater. As you see in Figure 133, the trees have a positive influence on soil temperature. The simulation shows that trees will lower the soil temperature by about 3°C (Langer, Sodoudi and Cubasch 2012). The residences are arranged around courtyards, making possible the installation of service water points. This water may be used for cleaning streets and cars, irrigating plants and trees, and other purposes where potable water is not required. Treated graywater which cannot be used (e.g. during a wet winter) will be fed into the rain water system to infiltrate back into the ground. This will, of course, have positive effects on groundwater recharge in the region of Hashtgerd.

5.3.2 Blackwater

Wastewater from toilets and kitchens will be collected together in gravity sewers. The blackwater should be treated in a central or semi-central WWTP. A more decentralized concept for blackwater was not considered suitable. To avoid odor problems, completely sealed systems would be necessary. A possibility would be containerized Membrane Bioreactor

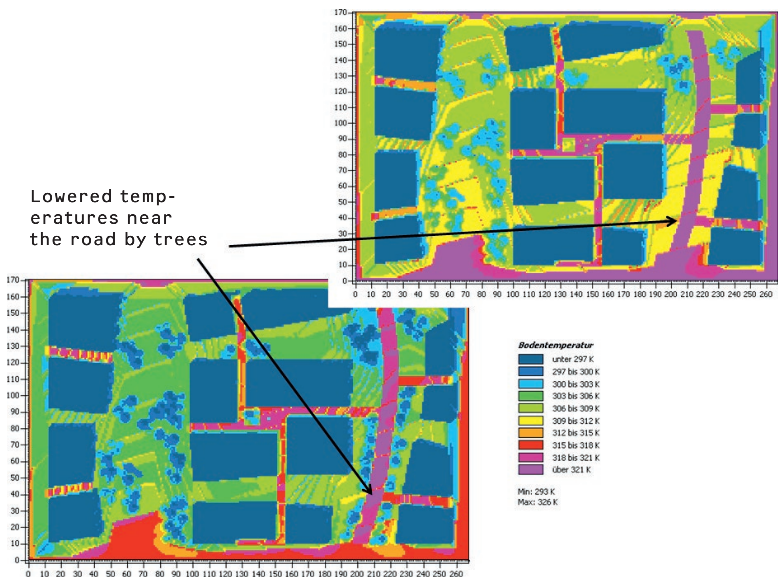


Fig. 133: The influence of trees on soil temperature (Langer)

plants; however, these systems have high investment and maintenance costs. Maintenance for a high number of installations spread over the whole city would be labor intensive. Since blackwater also generates hygienic issues, a central plant has the advantage of a single point of surveillance. Furthermore, a suitable receiving water is not located in the Shahre Javan Community area and the social acceptance of reused blackwater is much lower.

5.3.3 Stormwater

Rain water harvested from rooftops, sealed surfaces, and streets will be collected in separate sewer systems and transported by gravity to the lowest point in the southern edge of the Shahre Javan Community pilot area. There, the water will be mechanically treated. Floating material and sediment will be removed before the water flows into the infiltration pit for groundwater recharge.

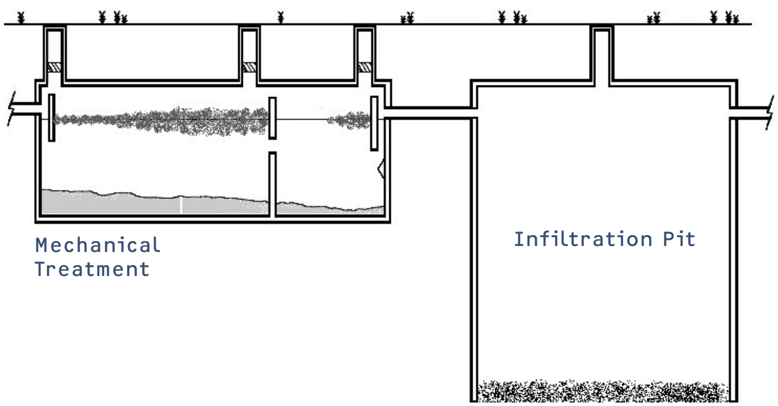


Fig. 134: Stormwater treatment (p2m berlin GmbH)

6 Integrated Transportation Approach for the Shahre Javan Community

Norman Döge | Wulf-Holger Arndt

The Tarh-e Tafsili (detailed plan) for the Shahre Javan Community pilot area combines many different planning disciplines. Its transportation concept has to be considered as a result of integrated planning and the associated interactive processes of all the participating planning disciplines. The following results are the outcome of these processes and are the local application of the general approaches for the MENA region which were presented in Chapter IV 6. The goal of transportation work, in the project context, was to mitigate energy consumption and CO_2 emission by addressing three main issues: "traffic reduction", "modal shift" and "safeguarding the mobility of the inhabitants". Given this, the emphasis lies on creating a general shift of attitudes and, from that, of daily mobility routines towards non-motorized and collective modes of transport.

6.1 Main Characteristics of the Iranian Urban Transport Sector

In general, Iran is a relatively low-motorized country. In 2012 there were 200 cars per 1000 inhabitants (ISNA 2012). However, this number is misleading as there are immense differences in vehicle ownership between countryside and urban agglomeration residents. High subsidies for fuel, the orientation of planning towards the needs of individual motorization, the marginalization of slow modes (walking trips are often not part of the traffic surveys in Iran), privatization attempts, negligence with the already disintegrating public transport system, and a change of life-styles have all led to growing private-car dependency. As a result, urban agglomerations now face heavy external (societal) and internal (in regard to the system itself) costs for transportation. In January 2013, life-threatening levels of air pollution led the municipality of Tehran to restrict car use on three separate occasions. Already in 2006, 28,000 Iranians died in traffic accidents and 2.5% of the world's traffic accidents took place in Iran (UNICEF 2012).

Moreover, the urban form and layout of new yet-to-be-built quarters and New Towns is heavily car orientated. This will make it even more difficult to implement cost-efficiently working public transport systems in the future.

Fortunately, however, the general framework and orientation of planning is changing. Within the last years the government and also the municipalities invested a lot of money in upgrading and extending public transport systems and networks for slow modes, while dramatically reducing subsidies for fossil fuels. In Tehran and Mashad for example, mass transportation systems like BRT (Bus Rapid Transit), Metro, and LRT (Light Rail Transit) systems have been extended. Tehran has also recently introduced a bicycle sharing program and started to build a bike lane network.

> ***"In 2025, Tehran should have an integrated, available, safe, easy, comfortable and clean transportation system considering the limitation of resources and other relevant conditions for improvement of life quality."***
>
> (TTTO 2013, p. 4)

Major future challenges will include: limiting the growth of private vehicles; the need to update and revise the transport planning paradigm to include a stronger orientation towards public transport and slow modes; creating better coordination between the different modes of public transport; and improving overall traffic safety.

6.2 Planning Prerequisites (Local Framework) of the Shahre Javan Community

The transport approach developed within the framework of the Young Cities research project focused on two main tasks. The first task included the elaboration of a transport concept for the Shahre Javan Community pilot area in the planned New Town of Hashtgerd. The second task was the development of a general public transport guideline for the town as a whole.

The originally suggested transportation network for the town, as presented in the revised master plan (report from Paykadeh Consulting), catered to individual motorized transport and was generally restricted to physical planning aspects (Paykadeh Consulting 2008s). Moreover, most detailed plans, as visible in the already built neighborhoods, emphasize the construction of dead end streets which are designed for the needs of individual motorization and, to some extent, isolate the neighborhood from those surrounding it.

In regard to public transport, the revised master plan only mentions the necessity to implement a bus system. Currently, it is also planned to extend one Tehran Express Metro over Karaj and into Hashtgerd to provide public transport for commuting to Tehran (Ibid., TTTO 2013 p. 7).

The land-use distribution, as proposed in the master plan, shows a clear concentration of high-centrality land-use in the geographical city center, with mid-centrality for the rest of the city, and no mention of low-centrality land-uses.

The city is located on a site with a dynamic topography of ridges and slopes. Since these topographical circumstances restrict accessibility for pedestrians, cyclists, and the disabled, the planner has two alternatives: either to level the terrain or find a way to connect trip origins and destinations in a way that the restrictive effects of the terrain can be circumvented.

It should be mentioned that, in the Iranian transport planning system only cities with more than 500,000 inhabitants have to develop a transportation master plan. This is quite a remarkable regulation that is often not the case in western countries. The City of Hashtgerd plans to have 660,000 residents and, therefore, has not made a master plan for transportation.

6.3 Goals and Strategy (Low Carbon Transport for the Shahre Javan Community)

The primary goal of the approach and research project is to support climate protection by developing integrated measures for improving the energy efficiency and reducing the CO_2 emissions of the transport sector. The main approach follows the motto of Sudarskis (2006): "Reducing Traffic and Increasing Mobility"

Secondary goals and the derived essentials of the transport concept are: support of the mixed land-use approach through adequate mobility systems; supporting social and spatial accessibility; the integration of all traffic modes; coequality of all modes but filtered permeability of spaces; support of sustainable traffic modes (slow modes, public transport); avoidance of through-going traffic in residential areas; increased traffic safety; participation of all stakeholders in the planning process; adaption to and conservation of topographical circumstances.

6.4 Integration of Hard and Soft Policy Measures

As already described, the measures and policies of an integrated planning approach for the Shahre Javan Community can be differentiated into four dimensions of implementation (Fig. 55).

An analysis of various transportation planning approaches from different cities all over the world showed that un-integrated approaches are one of the main reasons that implemented projects are unable to reach their estimated target values. In Iran, there already are efforts to restructure the transport sector in an ecologically-friendly manner. The main problem is that these attempts are largely un-integrated.

This approach tried to combine already existing measures with new ones that have been proven as successful in international context. The concrete outcome for the example of the Shahre Javan Community can be seen below, structured according to the above mentioned concept essentials.

6.5 Integration with the Land-use Concept and Demand Minimizing Land-Use Configuration (Mixed Use)

The mixed land-use concept prioritizes efficient land-use, shorter travel distances, and increased use of public transport. For this reason the approach connects the land-use concept with the planned city-wide public transport system as well as with walking and cycling networks. The central location of social amenities guarantees accessibility by foot with a maximum distance of 300 m (Arndt and Döge 2012). The results of several traffic simulations proved that the currently planned placement of land-uses with high centrality, such as a regional shopping center, a larger office building, and a secondary school, at the edges of the area will help to keep motorized traffic out of the quarter and ensure efficient access by public transport (Ibid.).

6.6 Prioritization of Slow Modes and Path Structures Guaranteeing Optimal Internal Connectivity

Planning transport networks for residential areas should always start with the slow modes. In the final plan, the pedestrian and bicycle network consists of hierarchically staggered categories, each with different user rights and growing capacities (see Fig. 135). The residential buildings organized in sub-neighborhoods are connected with each other via smaller pathways, accessible only by pedestrians, cyclists, and emergency vehicles (Ibid.). The heart of the Shahre Javan Community, which will be equipped with a mosque, kindergarten, and cultural center, will be accessible through an east-west platform called an urban connection. This is a sort of drivable and walkable artificial plateau that levels the differences in height between the settlement lines orientated on the natural north-south ridges. It is planned to include a route of the proposed neighborhood bus system and ensures a walkable connection to the planned BRT/LRT stop in the west of the quarter. The two north-south valleys between the four sub-neighborhoods along the north-south ridges are planned as corridors for access roads, the only drivable connections that provide access to the sub-neighborhoods.

On major thoroughfares, like main-, collector-, and access roads, pedestrian and bicycle traffic will take place in separate lanes. To facilitate a cultural shift towards ecologically friendly transportation routines, the non-motorized transport network must be attractive and secure. In order to increase amenity-, security-, and connection-functions, in line with the overall planning framework, lane widths are planned to be greater than the minimum requirements (according to German guidelines: pedestri-

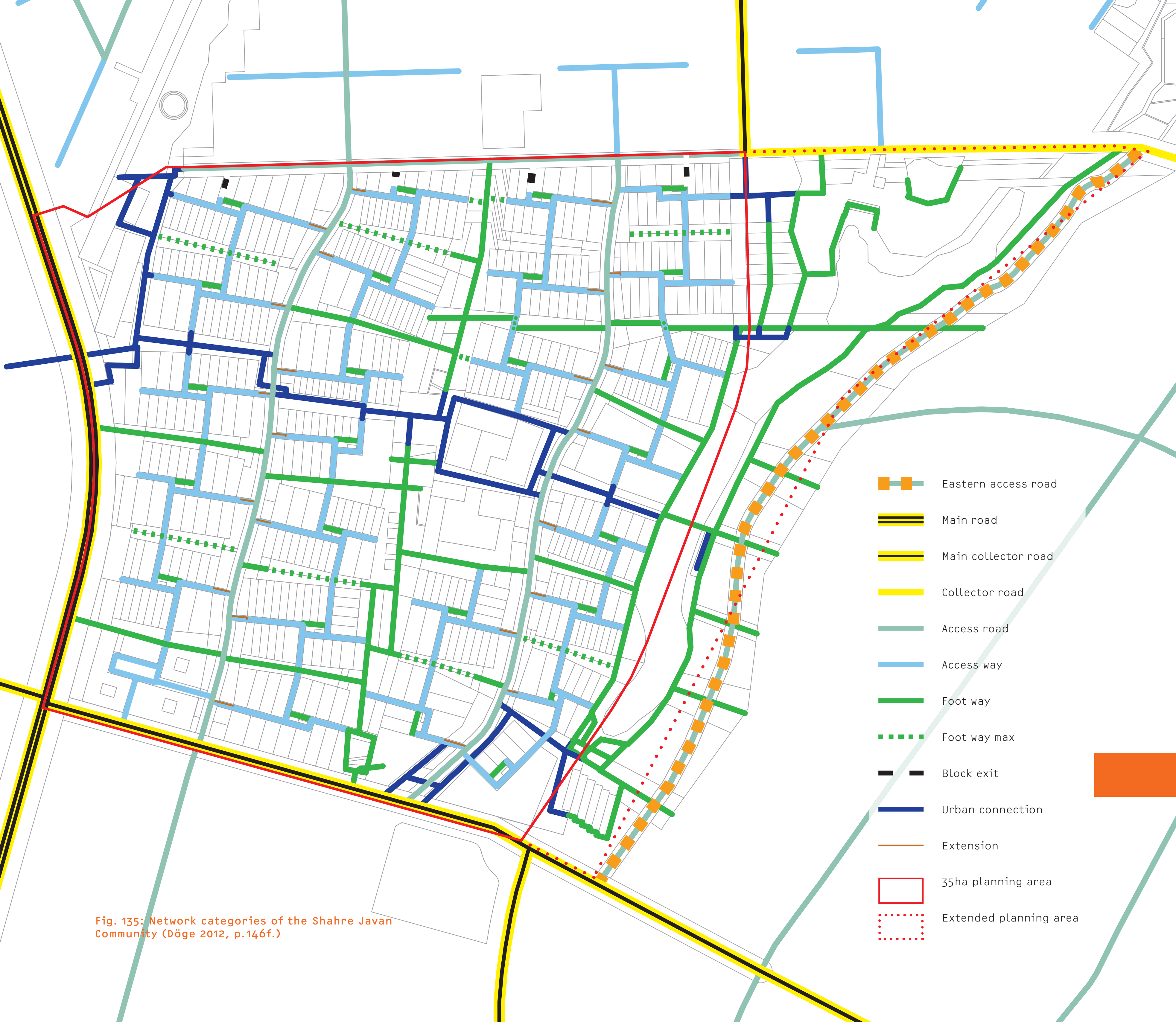


Fig. 135: Network categories of the Shahre Javan Community (Döge 2012, p.146f.)

an facilities at 1.8 m, bicycle facilities on roads at 2.3 m, and when next to sidewalks at 1.5 m including security space (cp. FGSV 2007).

In order to reduce traffic inside the pilot project area, as well as to support a modal shift, the concept emphasizes that street parking should only be permitted on the surrounding roads and limited to 0.2 lots per dwelling. This also includes parking lots for customers, visitors, and residents. Reorientation of mobility habits should be supported through an enforced shortage of family parking, and by placing the residential parking lots further than the next public transportation stop. The shortage and the placement will “push” residents towards a more ecologically friendly form of mobility. Furthermore, both the parking concept and the dimensions of traffic space will help minimize soil sealing (Ibid.).

6.7 Support of Public Transport and Energy-Efficient Vehicles

In order to guarantee transport’s horizontal spatial integration into Hashtgerd New Town, the Shahre Javan Community pilot area is planned to be surrounded by higher capacity transport systems like Citybus or Bus Rapid Transit (BRT). Furthermore, Bus Rapid Transit, in advance of a later Light Rail Transit (LRT) system, creates a commuter connection to the planned Hashtgerd-Karaj-Tehran Metro Line and to the city of Old Hashtgerd. The residential sub-neighborhoods and the center of the Shahre Javan Community pilot area are well-connected by a Minibus Line with a temporary demand-response stop service, allowing every inhabitant to reach a public transport stop within less than 250 m (Ibid.). This neighborhood bus will enter the area via the southwestern access road, then pass over the central urban connection and leave the area by the northwestern access road. The public transport system will be complemented by a taxi system, as is common in Iran. Several taxi stops will also need to be implemented—a service that could be combined with car sharing stations.

The public transportation approach of the Shahre Javan Community includes the following components:

- Minibus Line, crossing the Shahre Javan Community pilot area. The Minibus enters via the western access road, crosses the urban connection, and leaves the area via the eastern access road in a northern direction.
- Citybus Line, operating at the eastern access road.
- Light Rail Transit or Bus Rapid Transit, operating on the western main road.
- Two taxi stations at the intersection between the western access road and the urban connection as well as the eastern access road and the ‘urban connection’.
- Seven taxi and Bike & Ride stations

The basic accessibility patterns are visible in Fig. 136.

This hard policy strategy is planned to be accompanied by soft policy measures. The core of the planned transport management system, including regulations for customer services, information campaigns, etc., is what is known as a mobility package. This package is part of a movement assistance program that consists of informational material concerning the town and its public transport system, incentives like a test ticket for using public transport, and additional services that help motivate new inhabitants to rethink their mobility routines to encourage the shift towards environmentally friendly means of transport (Ibid.).

Fig. 136: Accessibility patterns of public transport stops in the Shahre Javan Community (Döge 2013)

6.8 Traffic Safety

In order to prevent conflicts between different modes of transport, car traffic is restricted to the surrounding access roads. Moreover, the general course of the drivable access roads uses the topographical circumstances to slow driving speeds with its meandering style (Ibid.). Crossings for the pedestrian and cycling networks are planned at above street level in order to highlight this element for drivers and to function as a speed bump. In general, path widths are above the usual standards and additionally equipped with extra security room, as with bicycle lanes on roads.

6.9 Barrier Free Access

Because of the pilot area's dynamic topography, there needs to be special designations for maximum road and path inclinations. To guarantee unimpeded access for disabled people as well as service, rescue, and delivery vehicles, the maximum inclination of access roads has to be limited to 5% (from the roads to the entrance of the sub-neighborhoods) (Ibid.). Barrier-free accessibility will be established through the 'east-west urban connection' with ramps and reduced inclinations (lower than 5%). Given the dynamic topography, whereby main roads are located in the valleys and the sub-neighborhoods are located along the ridges, the inclinations of the network elements connecting these need to be limited to a maximum of 15%.

6.10 Noise Protection

Noise protection will be reached indirectly through reduced individual motorized traffic, fixed personal parking facilities (less traffic searching for parking), and both the placement and orientation of the buildings.

7 Incorporation of Environmental Goals in Regulations in a Legally Binding Land-Use Plan in Iran

Bernd Demuth | Sara von Eitzen | Theresa Garske

In the course of sustainable urban planning for the Shahre Javan Community pilot area subdivision of the Iranian New Town Hashtgerd, the regulations for the consideration of environmental and nature conservation concerns in the binding land-use plan (cp. Chapter IV 7) are geared towards the legal possibilities represented in the German Federal Building Code (BauGB § 9).

The binding land-use plan of Hashtgerd offers justification and explanation of the following goals:

1. Saving water and protection of water resources (saving of drinking water, reuse of graywater, groundwater recharge),
2. Carbon-binding for climate change mitigation,
3. Sufficient supply of public green space in vicinity of residential areas.

7.1 Saving Water and Protection of Water Resources

General assumption: The protection and recharging of groundwater are priorities given the region's semi-arid climate and constantly decreasing groundwater level. Therefore, reducing water consumption and recharging groundwater should be a focus of sustainable planning.

Expert Background:

a) *Graywater recycling by constructed wetlands*
To facilitate the reuse of graywater (shower, sink water, etc.) from surrounding private households, constructed wetlands must be designated and regulated. After the graywater has been purified in the constructed wetlands, it can be reused for the irrigation of public and private, green and open spaces. The use of drinking water for irrigation is prohibited, making the goal to use solely graywater for green and open spaces. The constructed wetlands are spread throughout the area, taking advantage of a decentralized design in order to reduce the energy required for pumping. The dimension of each wetland area depends on the population within the catchment area, with 1 m² of wetland per capita. Thus 8,000 citizens will require 8,000 m² of constructed wetland—excluding the area required for technical infrastructure. All water entering and leaving the constructed wetlands will need to be measured, recorded, and regulated with water meters to allow for continuous monitoring tracked by a balance sheet. Cleaned surplus graywater from the constructed wetlands which is not needed for irrigation is used to recharge the groundwater. Groundwater infiltration will be decentralized, with water meters automatically registering the amount to allow for calculating total groundwater recharge by day, month, and year.

b) *Water saving maintenance activities*
Irrigation of public green spaces will use mandatory water saving irrigation techniques, such as drip or underground irrigation. Public green spaces will be planted with native and climate adapted (low water consumption) plants—the selection of plants will be regulated by the planting list. Continual maintenance is obligatory, including documentation (in order to adapt the maintenance/irrigation if necessary) and the replacement of dead plants.

c) *Designation of rainwater infiltration areas*
Since 286,499 m² of the project's surface area will be sealed, areas for surface water infiltration will be provided in order to sufficiently mitigate the environmental impact of the urban development project. Erosion from surface water run-off must be avoided, especially on hillside areas. Thus, infiltration areas will be built both above and below hillside edges. Major rainfall run-off will be collected in these areas and funneled to groundwater infiltration points.

Exemplary regulations for constructed wetlands in a legally binding land-use plan:

Constructed wetlands for graywater treatment need to be closed systems within the designated areas. The basin area should be planted with plants from the following list:

- Iris pseudacorus,
- Juncus ensifolius,

- Scirpus lacustris,
- Typha minima.

The areas required for technical infrastructure must be planted with shrubs and perennials according to the list of pre-selected plants. Irrigation is permitted only during the establishing phase and only if required. The amount of water flowing into the constructed wetlands will be measured and recorded by water meters at the entrance to the purification tank. Further water meters quantify and record the amount of water required for irrigation, as well as the remaining water used for infiltration.

Note: The planting distance in such a regulation accounts for ca. 30 cm for perennials and between 1.5 and 3.0 m for shrubs. These distances vary depending on the plant size, quality, and the local conditions.

7.2 Carbon Binding for Climate Change Mitigation

General assumption: Decreasing atmospheric carbon dioxide is an important part of climate change mitigation. Thus, increasing the carbon-binding capacity of landscapes in semi-arid regions should be a focus of sustainable planning.

Expert Background:

a) *Designating carbon binding areas*
Extensive "greening" with native plants (heat adapted and low water consumption) would significant increase carbon-binding capacity in urban landscapes, in both the vegetation and soil (Batjes 1999, p. 5). Due to the water scarcity in the region of Hashtgerd, it is not possible to use plants with high water needs, even if they can bind more carbon than drought tolerant plants requiring less water. Water availability significantly affects the amount of organic matter plants can create. In the semi-arid climate of the project area, the accumulation of organic plant material—and hence the extent of carbon sequestration—is limited due to low precipitation.
- It is assumed 2.6 tons of carbon can fized per ha within 5 years,
- 14.3 t/ha after 20 years,
- 20.9 t/ha after 50 years,
- 29.7 t/ha after 100 years (calculations based on UNPD 2003).

In absolute terms, the potential carbon sequestration in the project area is—in comparison to humid climates—rather low. Nevertheless, this amount is still a positive achievement as compared to levels before the project, the targeted planting of adapted vegetation significantly increases carbon sequestration. It is a complementary measure to reduce the CO_2-content in the atmosphere.

b) *Additional beneficial aspects*
Multiple nature conservation aims can be achieved at once by combining the designation of areas for carbon-binding and unsealed soils. An extensive planting effort can also be combined with efforts to prevent soil erosion and associated dust generation. Unsealed soil allows for rainwater infiltration and the evaporation of soil humidity, while simultaneously serving as potential habitat for a multitude of plants and animals. Thus, these areas are designated as "areas for protection, maintenance, and development of the natural environment".

Note: The project area is small in terms of global climate events, and thus, mitigation impact will also be small. However, these regions could be established as demonstration areas, where vocational, professional, and student training, as well as courses for environmental education can take place.

Exemplary regulations for carbon binding areas in a legally binding land-use plan:
- Planting according to the list of pre-selected plants.
- The irrigation of plants will take place only during the establishment phase and only if required.

Note: The planting distance in such a regulation accounts for between 1.5 and 3.0 m for shrubs. The distances vary depending on the plant size, quality, and the local conditions.

7.3 A Minimum Supply of Public Green and Open Space Near Residential Areas

General assumption: Ensure a minimum of 7 m² of public green and open space per capita. The legally binding land-use plan might not provide enough public green and open space within its territorial scope, which could potentially be compensated by areas within a nearby valley to the east.

Expert Background:

a) *Quantitative and qualitative criteria*
In order to guarantee abundant recreation opportunities in the vicinity of residential areas, public green and open spaces were designated as absolutely necessary in the Shahre Javan Community pilot area. The 7 m² per inhabitant requirement is drawn from Iranian and German default values for the provision of public green and open space. With a planned population of 8,000 inhabitants, about 56,000 m² of public green and open space will be needed. The minimum size of a single green space is 0.5 ha, with a minimum width of 15 m. The catchment area of the public green and open spaces should have a maximum radius of 500 m. Further, these public green

and open spaces may not be crossed by roads. To allow all population groups (e.g. senior citizens, disabled people, and toddlers) equal access to recreation opportunities, the areas must not be too steeply inclined. The major central park is not sufficient to meet the recreation demand of the residential areas. With an approximate area of 35,098 m², the park would supply only 4.38 m² of public green and open space per capita. To meet the additional demand of at least 20,902 m², the eastern adjacent valley will be designated as a public green and open space providing an additional 65,377 m² (cp. VI 8). The planned eastern street will need to be relocated to allow for this. Altogether, a maximum per-capita value of 12.56 m² is possible, assuming suitability of the additional areas. However, if this possibility should not seem feasible, the necessary amount of green space must be designated within Hashtgerd New Town and in the vicinity of the Shahre Javan Community pilot area.

b) *Sustainability of the public green and open spaces*
Large lawns or many trees with expansive canopies would not be sustainable. Landscaping should use plants adapted to the climate and prioritize water saving measures. When planning the choice, quantity, and placement of vegetation, not only the semi-arid climate conditions and the shortage of water must be considered, but also relevant economic, ecological, and social needs. When designating green and open spaces, both the regulations and the expert background explained in sections 7.1 and 7.2 above must be considered.

Exemplary regulations for public green and open spaces in a legally binding land-use plan:

- Only native and climate-adapted plants may be used from the pre-selected list.
- The use of drinking water for irrigation is prohibited. Irrigation water must be sourced from the graywater network of the constructed wetlands. The maximum daily withdrawal amount is limited and will be recorded and regulated by water meters (as part of balancing the graywater cycle).
- Water saving irrigation techniques (drip or underground irrigation) are mandatory.
- Continual maintenance (e.g. irrigation, replacement of dead plants) is required, as well as its documentation in order to continually improve the maintenance regime.
- Fountains and water basins must be fed with treated graywater (equipped with water meters for monitoring purposes).

7.4 Spatial Designation of the Regulations in the Binding Land-Use Plan

The exemplary regulations have been applied to public spaces in the Shahre Javan Community pilot area of Hashtgerd New Town. Shown below are examples of a designation plan from the binding land-use plan for the area.

Fig. 137: Exemplary regulations for public green and open spaces related to the above mentioned topics (1. Saving water, 2. Carbon-binding, 3. Supply of public green and open spaces)

7.5 Conclusion

The explanations given here are intended to give an impression of the German planning and building legislation’s (BauGB) scope of action for implementing environmental goals. They should show that it is possible to provide explicit and legally binding designations for green and open spaces in legally binding land-use plans to ensure sufficient areas for recreation and to secure the protection, maintenance, and development of the natural environment. Regulations for protecting the environment within a legally binding land-use plan require a regulatory depth and degree of precision like that in the German planning and building legislation (BauGB). Hopefully these examples will inspire the development of a legal foundation for environmental protection concerns in the Iranian juridical system.

8 Increased Consideration of Environmental Concerns and Impact Mitigation through Environmental Assessment in the Shahre Javan Community Detailed Plan

Holger Ohlenburg

According to Article 50 of the Iranian constitution "it is considered as a public duty to protect the environment" (DoE 2009, p. 24f.). Environmental conservation is explicitly highlighted as a planning objective in the first urban comprehensive plan of Hashtgerd New Town (NTDC 1993). However, environmental concerns were inadequately incorporated: neither the planning documents nor the physical urban structures considered environmental protection sufficiently.

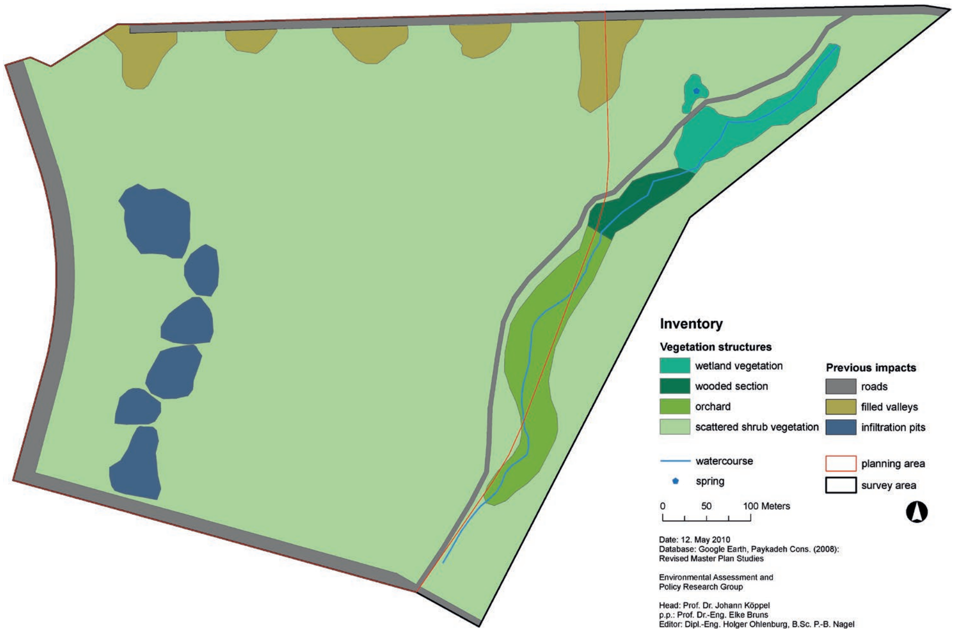


Fig. 138: Environmental inventory for the Shahre Javan Community area (red border) incl. extended survey area (Ohlenburg, Nagel and Köppel 2012b, p. 42)

To increase consideration of environmental concerns (i.e. environmental factors and its functions) was therefore a major necessary aspect of qualifying the Iranian urban planning process and practice. Based on international approaches, with the main emphasis on the German SEA system for urban land-use plans, an adapted Environmental Assessment has been developed and was applied in the urban planning and design process for the Shahre Javan Community pilot project area. In this context, the principles of the "mitigation hierarchy", the "no net loss approach", and the "polluter pays principle" were all implemented to the best of the planner's ability (cp. IV 8).

8.1 Environmental Survey and Environmental Impact Studies

In the context of the pilot project, environmental studies were prepared for the environmental factors of climate, soil, water, flora, fauna, and landscape scenery. Environmental impacts often spatially exceeded the boundaries of the formal planning area. Therefore, the respective survey area for each environmental factor was determined in relation to the various spatial scopes of likely impacts.

The content of the study was organized using the following structure for each factor:

- General relevance of the factor and its (ecosystem) functions;
- Information on the broader context;
- Inventory (related to the specific survey area) including documentation of previous impacts;
- Sensitivity assessment;
- Prediction of likely adverse impacts;
- Proposals of measures to avoid, mitigate, and/or compensate the impacts.

The sensitivity assessment and prediction of likely adverse impacts, the proposed mitigation and compensation measures, and further specific information related to each environmental factor, are all based on a simplified survey of the environmental inventory (see Fig. 138). Due to a lack of more detailed local information, the inventory is mainly based on the environmental studies of Paykadeh Consulting (2008b and c) as part of the reports concerning the revision of the comprehensive plan for Hashtgerd New Town, making it necessary to use some analogies and assumptions.

Biotope structures were identified early in the analysis at the eastern edge of the Shahre Javan Community area. They are considered highly valuable and have a high protection priority given their potential for biotope networking and recreation. The impact analysis of the first draft of the urban planning structure for the Shahre Javan Community area showed that these biotopes would be significantly impacted. Based on this, an alternative development proposal for the building structure and the access network, including a relocation of the eastern main collector road, was developed together with the urban and traffic planners. These two planning alternatives became the focus of further analysis and impact assessment. Building structures, road tracking, as well as existing biotopes and their direct losses are illustrated in the Figures 139 and 140.

The following section is a sample excerpt from the environmental assessment for the flora environmental factor as prepared for the Shahre Javan Community area detailed plan (Ohlenburg, Nagel and Köppel 2012b).

8.1.1 Survey and Impact Study for the Environmental Factor "Flora"

General relevance and functions

The flora and fauna of which ecosystems are composed supply a multitude of ecological functions. Species of both are closely connected to the maintenance of soil quality, an intact water regime, and the health of both the micro- and macro-climate, as well as providing a means of livelihood for local inhabitants. Flora and fauna are essential components of local ecosystems. Every effort should be made to minimize unavoidable environmental impacts and preserve local habitats. Negative impacts from modification, fragmentation, isolation, and pollution of habitats should be identified and mitigated.

Fig. 139: Planning alternative A with the road on the eastern edge based on the first draft of the detailed plan (Ohlenburg, Nagel and Köppel 2012b, p.42)

Fig. 140: Planning alternative B with relocated road and adapted building structure (Ohlenburg, Nagel and Köppel 2012b, p.43)

Broader context

Hashtgerd New Town is located at the fringe of the arid to the semi-arid Irano-Turanian ecoregion. This ecoregion is divided into two parts, with the "central Iranian plateau" in the south and the "higher mountain zone" in the north. The planning area is located in the north-western corner of the central plateau, where habitat types range from semi-desert to dry steppe. Throughout the ecoregion, woodland and scrub areas have been severely negatively impacted, and the area is now mostly treeless, with only a few remnant groves and scattered trees. The species composition of plant formations has also been altered; in many areas, dwarf-scrub formations of plateau grasses have been driven out and replaced by thorn cushions (Frey, Kürschner, and Probst 1985; Frey and Kürschner 1989)

Inventory Assessment

An assessment of environmental impacts usually involves biotope mapping: creating an inventory that describes and evaluates local flora and fauna on the level of biotopes or smaller-scale ecological or habitat units. Unfortunately, no detailed biotope mapping of the area is available. Therefore, the inventory was prepared based on broader scale material like e.g. the WWF 2001 ecoregions classification. It should be stated that the available information was not sufficiently precise for the scale/level of a detailed plan. Thus, the information was complemented with analysis made through Google Earth satellite pictures and additional on-site investigations. The survey area was enlarged to include biotopes east of the planning area to investigate that area's suitability for compensation measures.

Vegetation within the planning area is scattered (see Fig. 141). Dwarf-shrub vegetation (*Artemisietea herbae-albae iranica*) is common in large areas of the interior of Iran and, as a vegetation group, is very diverse and species-rich (Zohary 1973). In non-saline areas, variants of thorn-cushions (*Artemisietea herbae-albae astragaletosum glaucacanthi*) are common. Flats with better drainage are mainly inhabited by a variety of sagebrush (*Artemisia*). Other genera of the area include *Pteropyrum*, *Zygophyllum* and *Amygdalus*. Dwarf-shrubs of the genus *Artemisia* are found within the planning area. Certain species of thorn cushions occur more frequently along the ridges. Furthermore, a variety of small succulents have been documented.

At the eastern edge and within the adjacent area (extended survey area), there is a watercourse with accompanying riparian vegetation including: moist grassland species, some species of rush, a number of *Typha*, and even a few annual water plants. However, most notable is a section of *Platanus orientalis* (see Fig. 142). This species is listed in the International Union for Conservation of Nature's Red List of Threatened Species (IUCN 2010) as being of "lower risk/least concern". In the southern part, the watercourse is bordered by rows of orchard trees. The watercourse ends in a basin on the south-east corner of the planning area.

Fig. 141a+b: Scattered vegetation within the planning area (Ohlenburg 2010)

Fig. 142: Moist grassland with rush species and Platanus orientalis trees in the background (Grunwald 2010)

Fig. 143: Change of the morphology through filling at the northern edge of the planning area (Ohlenburg)

Present use and previous impacts

The planning area has not been previously used for agricultural or settlement purposes. However, it is assumed that the area has been used, at least temporarily, as rangeland for livestock. This may have caused a change in vegetation composition, as described by a WWF report (WWF 2001). Even though detailed information about the former vegetation composition is not available, greater anthropogenic impacts can be seen in sections outside of the planning area. At the edges of the area, roads have already been constructed or construction has already begun, resulting in significant loss of vegetation. Earth work activities, especially in the north of the planning area, along with the construction of wastewater infiltration pits, has caused a change of site characteristics and vegetation (see Fig. 143).

Sensitivity assessment

Sensitivity for soil impacts (e.g. sealing, compaction, excavation): All construction activities seal, compact, and displace soil, resulting in a loss of vegetation. The planning area, given previous impacts, has a medium sensitivity to such impacts. The water course, the riparian vegetation, the wooded section, and the orchard in the eastern part of the survey area have very high sensitivity.

Prediction of likely adverse environmental impacts

Planning alternative A would result in an additional sealing of 22.3 ha, displacing vegetation and causing a loss of biotopes. Even if a high share of the site remains unsealed, the development will cause a destruction or negatively impact of the existing vegetation. Planning alternative B would result in an additional sealing of 21.8 ha, but allow the preservation of the wooded section, the water course, and the riparian vegetation.

Possible avoidance and mitigation measures

The following measures would help to avoid and/or mitigate negative impacts on flora and fauna:

- Careful and resource efficient use and sealing of soil in construction of housing, roads, etc.;
- Reduction of the total sealed area by designating building lines and boundaries with an eye to preserving open and green spaces, especially the wooded section, the orchard, and the watercourse at the planning area's eastern edge.

Possible compensation measures

The following measures would be suitable to compensate negative impacts on flora and fauna:

- Designation of areas and measures for protection, maintenance, and development of natural landscape within and outside the planning area. The extended planning area is especially suitable for this;
- Enlargement of the wooded section by planting more Platanus orientalis trees;
- Creating an orchard biotope by planting orchard trees;
- Relocation and restoration of the watercourse, including the planting of riparian vegetation.

8.2 Implementation of the Mitigation Hierarchy and the No Net Loss Approach in the Project Context

Concerning the mitigation hierarchy (see IV 8), priority should first be given to avoidance: what cannot be avoided should be minimized and what cannot be minimized should be mitigated with compensation for impacts on soil, ground/surface water, climate/air, flora, fauna, and human health. In the project context, avoidance and minimization were implemented during the planning process through the optimization of the urban design, e.g. the building structure and the relocation of the eastern access road.

Unavoidable sealing, soil movement, human-caused environmental degradation, or any other negative environmental impacts (e.g. loss of habitats, biotopes, and environmental services) should be compensated via environmental enhancement measures within the planning area or off-site.

In the project context a simplified area-based approach has been used to calculate the compensation demand. The amount of compensation area required (A comp, demand) is calculated using the total sealed, or otherwise negatively impacted, area (A imp) minus the previous impacts (A prev. imp.) (e.g. existing roads, buildings, fillings, wastewater pits), which are not counted as compensation demand. This results in the following equation:

$$\mathbf{A}_{\text{imp.}} - \mathbf{A}_{\text{prev. imp.}} = \mathbf{A}_{\text{comp. demand}}$$

Figure 144 shows the sealed surfaces causing compensation demand minus the areas already impacted before project realization.

As stated in Chapter IV 8, compensation sites and measures should have a spatial and/or functional relation to the impacts, and should ideally be located within the planning area itself (A comp. int.). However, it would also be appropriate to designate off-site measures (A comp. ext.), as long as a functional, and more or less spatially close, relationship to the impacts is maintained. Compensation demand and designated compensation areas (within and outside of the planning area) should be balanced, so that a no net loss of environmental function is reached:

$$\text{GOAL: } \mathbf{A}_{\text{comp. demand}} - \mathbf{A}_{\text{comp. int.}} - \mathbf{A}_{\text{comp. ext.}} = \mathbf{0}$$

All area quantifications have been made with the support of Geographical Information Systems (GIS).

8.3 Legally Binding Designation of Compensation Areas and Measures

In order to meet the compensation demand, "public open and green space areas" as well as "areas for protection, maintenance, and development of the environment" have been designated in the Shahre Javan Community

Fig. 144: Sealed area without previous impacts causing compensation demand (Ohlenburg, Nagel and Köppel 2012c, p. 85)

detailed plan. Areas were suitable and counted for compensation areas if they were at least 100 m^2 in size and if designated measures for enhancing the natural environment and landscape were realized (see Fig. 145).

Due to a lack of suitable areas within the Shahre Javan Community area, a large portion of the planned compensation measures cannot be implemented within the scope of the western 35 ha planning area. Therefore, additional measures have been developed for implementation in the extended planning area. The maintenance and development of the eastern valley's vegetation and the watercourse also offer the possibility of creating a biotope network with the adjacent northern valley drain. Additionally, the area is being located close to the residential areas, making it suitable for recreational use. Because of this recreational potential, the development of these measures was prepared in close cooperation with Landscape Planning (see IV 7 and VI 7). Landscape and environmental planning measures fulfill multiple goals and sub-goals simultaneously by having positive impacts on many or all of the environmental factors and functions.

Final area calculations have shown that, within the formal detailed plan area, only 4.5 ha of the compensation demand of 22.3 ha could be realized. The additional compensation areas and measures in the east adjacent extended planning area contain another 6.2 ha of compensation area and measures. This leaves another 11.6 ha demand for compensation areas and measures which should be realized off-site.

In the following an excerpt of general and specific regulations and obligations based on Ohlenburg et al. (2012a) is presented, as well as the respective plan "Designations of Landscape Planning incl. Environmental Compensation" (see Fig. 145):

General designations, applying to all open and green spaces

- Rainwater run-off (from roofs, footpaths, and squares) must be collected and sent to the constructed wetlands or directly infiltrated in adjacent open space. In order to avoid surface run-off soil erosion, infiltration areas must be built above and below hillside edges;
- Rainwater run-off from roads will be collected in the sewage system;
- Planting efforts must use native and climate-adapted plants;
- It is prohibited to use drinking water for irrigation. Irrigation water must be from the graywater network of the constructed wetlands. The maximum daily withdrawal amount is capped and will be both recorded and regulated by water meters (as part of the balance of the graywater cycle).

Designations applying to areas of protection, maintenance, and development of the natural environment and landscape

- Uncompacted natural soil must be protected;
- The existing eastern road must be removed and compacted soil loosened;
- Soil deposition (fillings) or construction activities are not permitted;
- Infiltration or discharge of wastewater or untreated graywater is prohibited;
- Irrigation should be minimized (e.g. only during the establishing phase and only if required).
- Landscape development and maintenance must be carefully documented and monitored to allow for adaptations.

A Wetland vegetation

- Existing wetland vegetation must be preserved;
- The soil of the road area adjacent to the spring must be loosened and the original topography must be restored;
- Additional native wetland vegetation (Typha, rush and moist grassland species) must be planted.

B Wood (Platanus orientalis)

- Existing trees must be preserved and 20 Platanus orientalis will be planted (quality: standard, three times replanted with bale and min. 14 to 16 cm trunk diameter).

C Orchard

- 50 orchard trees of the existing species will be planted (loose plantation in two rows besides the watercourse (quality: standard, three times replanted with bale and min. 14 to 16 cm trunk diameter).

D Carbon binding area

- Plants from plant list A will be planted 1 x 1 m apart;
- Plants should be irrigated only during the establishing phase and only, if required.

Watercourse (to be preserved)

- The existing watercourse must be preserved;
- The removal or damage of riparian vegetation is prohibited;
- Additional native wetland vegetation must be planted (Typha, rush species etc.);
- The piping of the watercourse in the northeast must be modified to allow mammals passage.

Watercourse (to be restored)

- The existing watercourse has to be restored to its natural character for a length of 100 m;
- Native riparian and wetland vegetation must be planted along the river bank (Typha, rush species etc.).

Fig. 145 (next page): Plan with designations of landscape planning incl. environmental compensation (based on Pahl-Weber et al. 2012, p.142f.)


20 m 50 m 100 m 200 m
Authors
H. Ohlenburg, B. Demuth, P. Nagel, and T. Garske
Protection, maintenance and development of nature and landscape
A Wetland vegetation
B Wood (platanus orientalis)
C Orchard
D Carbon dioxide binding
Public open space
A Dry green
B Lush green
C Green connection
D Infiltration area
Compensation and recreation area
Compensation area
Recreation area
Private open space
Constructed wetlands
Green roof
Watercourse to be preserved
Watercourse to be restored
35ha planning area
Extended planning area

9 Citizen Participation and Citizens Exhibition in Iran and Hashtgerd New Town

Sabine Schröder

During the last few years, the topic of participation has been gaining importance in Iran—in scientific fields, as well as in both practice and rhetoric. This is all the more interesting given that Iran is not the first country to come to mind when one thinks of participation. When it comes to the preparation, approval, and implementation of urban development plans, the degree of citizen participation in Iran is still low compared to other countries. The lack or low level of participation was identified as one of the major reasons for the failure of implementation and execution of urban development plans (Ministry of the Interior 2000 and 2001 cited in Mohammadi 2010), which leads to a "lack of realism in goal setting, inaccuracy, inefficiency [..] and inequity in urban development plans" (Ibid.). However, there have been some innovations in Iran since the end of the 1990's to foster decentralization, participation, and empowerment.

The Shora-Yaaris, co-councils at the neighborhood level, are one element of a process of decentralization which began in 1999 with the establishment of city councils. The Shora-Yaaris are staffed with resident volunteers and represent the interests of the neighborhood by identifying problems within the community, proposing solutions, and communicating them to the City Council (see Mosavat, Seelig and Stellmacher 2010). The Shora-Yaaris are based on an initiative by Prof. Parviz Piran who also initiated the School Mayors Project, another participative approach which has become widely known in Iran (for further information see Piran 2005).

Another innovation is the installment of facilitation offices in urban regeneration areas in Tehran. These serve as one stop shops for residents to address the problems and needs of the neighborhood, with the goal of creating solutions and small-scale projects in cooperation with the residents for the enhancement of the neighborhood.

However, in Iran there are no binding laws that require the integration of citizens in planning processes. Therefore, there is hardly any legal or institutional basis for citizen participation. Furthermore, the term "citizen participation" is in many cases not understood as a sharing of power with the citizens, or an integration of the citizens' perspectives, but as participation of citizens in the funding of a project. Thus the citizens are asked to participate in financing a project, which shows an entirely different approach to the term "citizen participation".

9.1 Participation in New Towns in Iran

New Towns are planned towns that are rather young and, thus, have not grown over decades or centuries like traditional cities, which has implications for the structure of civil society. Inhabitants might not identify themselves as much with their town or neighborhood, as is the case for traditionally grown neighborhoods, as they often move there because they could not afford to live in the bigger cities, as in the case of Hashtgerd in Tehran. Therefore, the newer residents can be less motivated to engage in activities for the benefit of their town. Also, there are either only fledgling civil society structures (such as civil society organizations, NGOs, or associations) or the existing ones are not stable due to the young age of the New Towns.

Before starting a participative process in a surrounding that is not well known to the project facilitator, it is useful to first conduct an actor analysis in order to identify relevant actors.

In Iran, the New Town Development Corporation (NTDC) is responsible for the development of the New Towns. In the beginning stage of a New Town the local NTDC is in charge of the town. When the New Town reaches 10,000 inhabitants a municipality is established, and a city council and mayor are elected. However, the NTDC still remains in charge of the urban development of the New Town (for this and the following see Farshad 2011). For Hashtgerd New Town, the Mayor's Young Consultants have been established as a link between the residents and the municipality in order to integrate the perspectives and ideas of young people. The social structure of the residents often varies in the different building phases of New Towns, depending on the different selling strategies that have been applied by the NTDC, which can also affect the readiness of the residents for participation. In Hashtgerd New Town, the residents of building phase I are mostly employees of different public corporations, which have bought the land and then sold or rented it to their employees, while the land of the second building phase was sold directly to individuals. Because residents have lived in Hashtgerd New Town longer in comparison to the residents of other building phases, and have better access to facilities, the "readiness of the first group to take part in the events designed and managed by the municipality is considerably higher in comparison with that of residents in other parts of the city" (Farshad 2011). The not yet fully developed building phases IV and V are reserved for the "Mehr" Housing Program, which was established to accommodate people with low-income and will therefore bring in a new and differently structured group of residents.

9.2 Example: Citizens Exhibition in Hashtgerd New Town

The participative-aesthetic method Citizens Exhibition, which was developed in the 1990's in Germany as part of social research in neighborhoods that were confronted with social or urban change (see Legewie 2003), was chosen for the Young Cities project. The method was recognized as a high-quality means for communicating the results of a survey that had been conducted with residents of Hashtgerd New Town to the Iranian partners and the inhabitants of Hashtgerd New Town, despite scepticism about the need for including resident perspectives in building projects, because the method uses the commonly known and accepted concept of an exhibition. For a short description of the method see Chapter IV 9.

The Citizens Exhibition, "Young Cities—Developing Urban Energy Efficiency: A View from Hashtgerd Citizens" presents the attitudes and knowledge Hashtgerd New Town residents have about climate protection, energy efficiency and energy-efficient building, their energy consumption behavior in the household and regarding mobility, as well as their assessment and contentment with the current infrastructure conditions of Hashtgerd New Town.

In order to design attractive, sustainable housing solutions, it is essential to know if and how sustainability matters to the people. With this information, we can then determine in what ways energy-efficient building can be a marketing asset, and how it can enhance living conditions in regard to the current conditions in Hashtgerd New Town. The survey conducted on the basis of the Citizens Exhibition, as well as the Citizens Exhibition itself, gave a first insight into these questions (for this and the following description, as well as more detailed information see Schröder, Schmithals and Poor-Rahim 2011; Schröder and Schmithals (in prep.) and Schmithals and, Poor-Rahim (in prep.)).

The survey showed that the majority of the respondents feel threatened by the consequences of climate change and almost three fourths think that humans are responsible for climate change. All respondents thought that actions have to be taken against climate change. However, most of the respondents consider climate change mitigation to be mainly, or at least partially, the responsibility of the state. Although many people stated that cooperation between citizens and the state is also necessary the state has the duty to create the necessary conditions for energy-efficient behavior (e.g. inform the citizens, provide infrastructure, e.g. adequate public transport, adopt and enforce laws). The interviews showed that household energy is an issue, e.g. some make efforts not to heat all the rooms during the winter, use energy-saving light bulbs, or buy energy-efficient household appliances. However, energy saving efforts are often confounded by the poor condition of the buildings, such that energy saving measures consist of sealing up the windows or other leaking spots. Most interviewees had heard about energy-efficient building, but most of them only associated double-glazed insulated windows and insulated exterior walls with the term. Technology-oriented solutions for energy-efficient building were not mentioned and may not be well known. Also, there were differing opinions on the feasibility of energy-efficient building in Hashtgerd. Some voices called for better laws and better law enforcement regarding energy-efficient building, and some thought that energy-efficient building was too expensive.

Regarding transportation, although two thirds of those interviewed lived in a household owning a car, nearly all of the interviewees expressed wishes for improved public transport, including: Metro lines to Karaj and Tehran, reliable bus schedules, increased frequency of buses, and more comfortable public transportation. Furthermore, Hashtgerd New Town, according to the respondents, lacks social, recreational, and shopping facilities. This forces the inhabitants to commute to Old-Hashtgerd, Karaj, and Tehran, leading to longer travel distances which increase energy consumption. This shows that resource-saving behavior is also hindered by the condition of transport, social, and recreational infrastructures in Hashtgerd New Town. The survey showed that energy consumption behavior, and the potential to reduce energy consumption, is closely linked to urban planning and architecture. The Citizens Exhibition promised to be a good opportunity to bring this connection, and the need for change regarding the living conditions in Hashtgerd New Town, into public awareness using the voices of the inhabitants.

The development and application of this method in Iran, and in an Islamic context, necessitated various adaptations. The interviews had to be officially registered and could, as a result, only be carried out in the presence of a government guardian (moral guardian) (In general, for most activities such as conducting interviews, or entering an official building like a university, it is necessary to obtain an official permission by the appropriate authority. A letter of recommendation should be carried by interviewers while conducting the interviews). However, the interviewees answered just as openly and extensively in the presence of the guardian as did the interview partners in the few cases in which the guardian was not present. In some cases, female interview partners invited the interviewers inside. As men cannot enter these places, these interviews were conducted without a neighborhood guardian. Thus, when doing projects in Iran, it should be taken into account that communication between men and women is regulated more strictly than between same sexes and can therefore be more complicated.

Fig. 146 a + b: Posters from the Citizens Exhibition in Hashtgerd New Town (nexus)

In contrast to other examples of Citizens Exhibitions, the interviews were not allowed to be recorded so that the interviewers had to take detailed notes, and, due to social norms, no pictures of the interviewees could be taken, which are usually essential for the Citizens Exhibition. Also, it was not allowed to take down the personal information of the interviewees, information which is usually shown on the posters and serves to invite the interviewees to the opening of the exhibition. Therefore, the concisely noted quotations were sorted according to topic, instead of according to persons, together with the sex, age, and building phase of the interviewees. These were presented on posters with pictures relating to the topic.

The Citizens Exhibition was prepared both in English and Farsi in order to make them understandable in both local and international contexts. It was opened during the inauguration of one of the pilot projects of the Young Cities project. Although the interviewees could not be invited personally (as stated above), politicians, representatives of the Building and Housing Research Center (BHRC), the NTDC, and the media were present. The Figures 147 and 148 give an impression of the posters of the Citizens Exhibition.

The experience of the Citizens Exhibition in Iran showed how the method is a well suited participative and communicative method which can be implemented even when participation is seen with skepticism. There are fewer obstacles than with other participatory approaches, as interviews and exhibitions are widely accepted concepts. Also, the method could be adapted to the Iranian cultural context through some conceptual changes, and can thus be recommended for implementation in different cultural contexts.

10 Monitoring the Shahre Javan Community Pilot Project

Leslie Quitzow | Peter-Diedrich Hansen

The importance of monitoring urban sustainability is broadly acknowledged but not yet broadly implemented in Iran. It is slowly gaining importance, most notably in the capital city of Tehran. The cities of Tehran and Urmia are members of the Global Urban Indicators Facility (GUIF), a "master system of global city indicators that measure and monitor city performance and quality of life" that enables cities "to measure, report, and improve their own performance in the areas of city services and quality of life" (*http://cityindicators.org/aboutus.aspx*). Perhaps symptomatically, both cities are officially members, but no data has been deposited on the GUIF website yet.

Nevertheless, collaboration in the Young Cities project—one of the very few joint international research initiatives with Iran—shows that Iranian decision-makers give the development of skills and expertise in resource-efficient and climate-sensitive urban planning a high priority for the country's future. If these new goals are to be reached, then progress towards them will have to be monitored. The following chapter explains how the Shahre Javan Community pilot project was monitored. It discusses important lessons that were learned in the process and gives an overview of relevant institutions for urban monitoring in Iran.

10.1 The Process of Monitoring the Shahre Javan Community

The Shahre Javan Community pilot project was planned by an international, interdisciplinary team of scientists as part of the Young Cities research project. The project's monitoring system was designed to observe the achievements of each research dimension, but also to monitor progress towards the planning goals. It thus captured research related activities such as publications and talks, as well as all planning related activities such as the amount of green and open space per projected inhabitant. The present chapter focuses on how the planning process was monitored, and derives general recommendations for monitoring sustainable neighborhood development. It DoEs not, however, discuss how to monitor a research project. The planning process was monitored from the early stages of conception to the formal adoption of the pilot area's detailed plan by the Iranian authorities. Any calculations, for example of parking space or resource consumption, were therefore based on plans and simulations rather than actual measurements. If the project is realized in the future, monitoring can and should continue throughout and beyond the construction phase.

The monitoring system was developed on the basis of analyses of various leading international urban monitoring and community certification systems. These include the German "Bewertungssystem Nachhaltiges Bauen" of the DGNB, the British BREEAM-Communities, the American LEED-ND, the Siemens Green City Index (GCI) for Asia, Africa, and Europe, the Egyptian Green Pyramid Rating System, and the ESTIDAMA (Pearl) rating system of the United Arab Emirates. The analyses resulted in the formulation of the following monitoring categories, which were adjusted to the specific project context of Hashtgerd (see also Chapter IV 10.3.2): urban form, architecture, green and open spaces, mobility, energy management, water and wastewater management, governance, public awareness, and capacity development (the category "solid waste management" was also identified as relevant, but not included in the monitoring system, because it wasn't covered by the Young Cities research project). Qualitative and quantitative indicators were chosen as monitoring tools for each category to reflect the level of goal achievement in relation to the overarching project objectives of reducing CO_2 emissions, reducing resource consumption, and achieving sustainable neighborhood development.

As a first step, all relevant project data was organized in a logical framework matrix according to the following parameters: objectives, objective indicators, measures and goal-orientated strategies, data of initial situation, expected impact, impact indicators, target values, and results. The indicators were chosen and monitored by each researcher individually, and then revised and adapted by a monitoring team. All qualitative and quantitative results were rated on a scale of 1 (best) to 10 (worst) and visualized in a web chart. The project members defined their benchmarks and rated their results subjectively, relying on international standards wherever possible.

10.2 Including the Necessary Budget and Staff

The Young Cities project provided staff and budget for monitoring from the very beginning. An internal working group composed of one member of each planning dimension was formed at the start of the project. It met at regular intervals, and was responsible for creating the monitoring framework and developing relevant indicators for comprehensively measuring the project's success. The working group discussed possible indicators, data sources, units of measurement, benchmarks, the quality of results, possibilities for their visualization, and an internal and external communication strategy. While simulations were conducted by the research teams themselves, the monitoring group ensured that results were comprehensibly documented and systematically communicated to all project members. Since monitoring encompassed all project dimensions, it was headed by the project's steering (or management) core.

10.3 Monitoring on the Basis of Plans and Simulations

It is important to note that the Shahre Javan Community pilot project was monitored solely on the basis of plans and simulations, because construction was postponed beyond the due date of this publication. The simulations of the micro-climate were conducted with ENVI-met, the energy performance of individual buildings was simulated with EnergyPlus, DesignBuilder, and Modelica/Dymola, and, finally, various energy management systems for individual buildings, building clusters, and the entire neighborhood were simulated with Modelica/Dymola. All simulations were repeated with slight variations in several cycles, and the architecture and urban design were adjusted according to these results.

The possibility of monitoring and subsequently adjusting plans clearly applies only when a new neighborhood is being developed; in the more common case of an existing neighborhood, monitoring requires a more original, location-specific set of indicators and tools. One major difference in a newly planned project is the absence of residents to engage in a participatory monitoring process. In the Young Cities project, participatory monitoring will only be possible in a second stage, when construction is complete, residents have settled in their new homes, and a community has started to form.

Since monitoring in the Shahre Javan Community project was only possible on the basis of simulations, it was limited to one cycle. In the case of a built project, monitoring should continue during the construction process and after construction is complete. This way, problems that occur during the first construction phase can be identified and avoided in the following phases.

10.4 Baseline Data

A valid interpretation of simulation results can only be accomplished in the presence of sound baseline data. In the case of the Young Cities project, data was needed to compare the energy performance of the Shahre Javan Community with the average energy consumption of a "typical" Iranian neighborhood in order to determine whether progress had been made. Similarly, baseline data was needed to calculate the average reduction of CO_2 emissions. The data sets were ascertained on the basis of simulations on the one hand, and values that were available for Tehran province on the other (all calculations refer to the former Tehran province, which still included Alborz province). Baseline data on the neighborhood level was not available. Approximations are a common necessity in planning and should not discourage monitoring. In some cases, comparisons can be made with other simulations: in the Young Cities project, for example, different varieties of architectural forms were simulated and compared with each other. This made it possible to derive the most energy-saving form, orientation, percentage of window area, etc. for the office building.

10.5 The Challenge of Calculating CO_2-Reduction

One of the central research and planning goals was to significantly reduce the pilot neighborhood's CO_2 emissions compared to those of an average Iranian neighborhood. The calculation of CO_2 emissions was therefore one of the project's key challenges. The Shahre Javan Community's CO_2 emissions were calculated on the basis of simulations that reflected the energy consumption of the development's buildings and transportation system, using the CO_2-emission factors for all different energy carriers involved (electricity, gas, oil). The specific CO_2 emissions per capita and year were balanced for the project area and then extrapolated for Tehran province in order to estimate the project's potential impact in the region. The projected reduction of CO_2 emissions was estimated on the basis of two energy consumption scenarios for the year 2027: one scenario assuming "business as usual" and a second scenario assuming urban development according to "Young Cities recommendations", i.e. buildings and transportation systems with reduced energy consumption. This second scenario was grounded on the supposition that up to the year 2027 a total of 2% of all new construction in the area is built according to Young Cities recommendations. If so, the calculations suggest that CO_2 emissions in the region can be reduced by 16%, from 1.97 t to 1.65 t CO_2 per capita and year through Young Cities interventions (Huber, Nasrollahi and Arndt 2011).

10.6 Where to Find Urban Sustainability Data in Iran

Currently, the institutional setting for measuring city or neighborhood sustainability in Iran is diverse. Many different, mostly governmental institutions collect data on a wide range of issues concerning city sustainability. Information is generally gathered by sector, and spread across various institutions (Mirgmoghtadaee 2012 and Fathejajali 2013). At the city level, municipalities keep the largest and most relevant amount of data on sustainability issues. The larger cities have GIS data bases of all districts which include information such as the socio-economic structure of the population, land-use, building ownership, density, road networks, and traffic and public transportation—to name only a few. Data is not sold to the broader public, but can usually be acquired with a statement of purpose from an official institution (e.g. an employer or university) (Ibid.).

Online plans are also a valuable source of information. Tehran municipality is the clear leader in terms of both the amount of published data and its online accessibility, but other municipalities are quickly following its example. In many cases, municipalities commission the elaboration of the detailed urban development plans to private planning practices that are responsible for collecting the necessary data either on the ground or from the ministries. Contacting these private planning offices can be the most direct way to access data (Ibid.).

Not all information is available at the city level. The national Ministry of Road and Urban Development and the Ministry of the Interior have some of the most important data bases for city sustainability. For certain sectors, such as the water and sewage sector, data is only available from the responsible national ministries or their agencies. Relevant sustainability data is most likely to be found in the Department of the Environment (especially its Office for Climate Change), the Ministry of Energy, and the Ministry of Petroleum. Information is often collected in the ministries' subordinate institutions, such as the International Institution of Energy Studies, the Iranian Fuel Conservation Company (IFCO), or the Iran Energy Efficiency Organization (IEEO/SABA), all of which are subordinate to the Ministry of Energy (Ibid.).

The most common data sets are available at the Statistical Center of Iran, which publishes most of its regular census data; in the case of Tehran there is also the Tehran GIS Center, and the Statistics Center for Tehran. In general, sustainability data is most readily accessible in the larger cities, such as Tehran or Mashhad, where institutional staff and private sector consultants are well-informed of the ongoing debates surrounding sustainable urban development (Ibid.).

Apart from the above-mentioned governmental institutions, private organizations, universities, and research institutes also collect data. The Central Bank of Iran and Tehran University's "Center of Excellence in Sustainable Urban Development" deserve special mention in this context.

VII

Résumé and Key Principles

Résumé and Key Principles

Elke Pahl-Weber

The team of researchers and experts involved in the various dimensions believe in a strategic combination of analytical, conceptual, and design approaches. Applied through a method of research by design, these approaches produce urban design solutions, based on resource efficiency and climate sensitivity, as part of a holistic concept which considers local conditions and global needs.

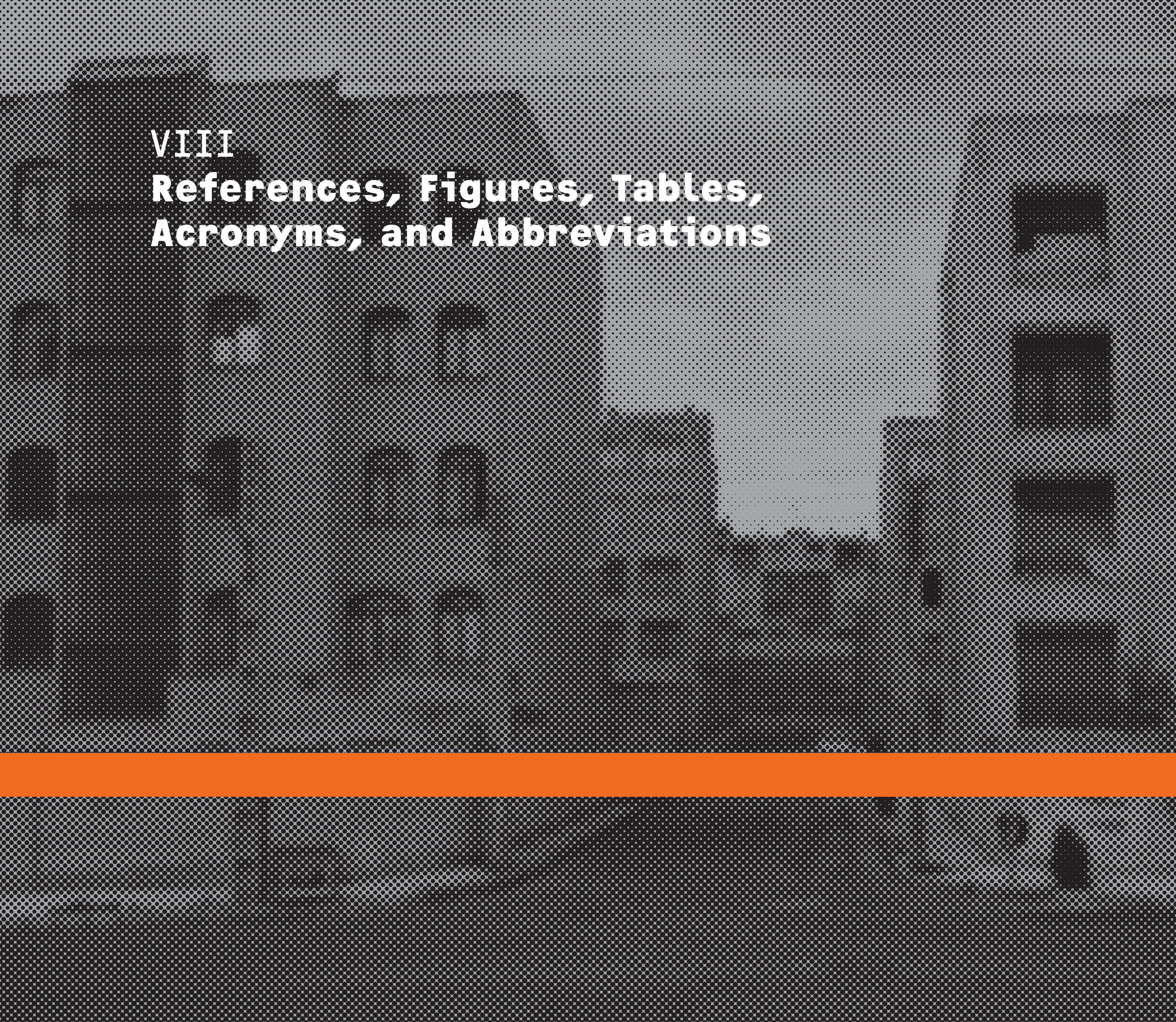
Unfortunately, due to the configuration of the research team, particular attention could not be given to the fields of waste management, economy, or lifestyle. However, the authors are aware that these aspects are interlinked with resource and energy demand. A further investigation considering these factors is highly recommended for future research.

One key aspect should be stressed as the most important tool in city design: constant negotiation and dialogue between planning disciplines is crucial to meeting the demands and needs of any urban development. The authors believe that discussion about the city of the future and the development of cities and their parts is not only for the various planning disciplines but must also involve civil society, institutions, administrators, and politicians. Bringing the knowledge of the professional sphere together with the user's perspective—combining physical elements and with actual social use—will shine the most light on how to envision the city of the future. This book is mainly intended to be the jumping off point for the development of visions, for without visions to guide us, there can be no innovation.

- The authors wish to stress the following key principles of energy-efficient and climate-sensitive design for the MENA region.
- The local and regional contexts, together with the population's socio-cultural background, are major influencing factors in the designing of urban form. Possible contradictions between the requirements of the many components and disciplines need to be balanced in a site specific solution
- Resource efficiency in urban form can be achieved through passive measures. Rather than enhancing efficiency through technology, urban form offers the opportunity to generate efficiency through innovative and intelligent spatial arrangements. Urban design helps to integrate disciplinary and stakeholder perspectives into applicable solutions.
- Providing a mix of uses at all planning levels, from building to block, quarter, and city, helps to reduce motorized travel and, thereby, to reduce energy demand.
- Integrated planning approaches, i.e. integrating all disciplines and stakeholders across levels, leads to planning processes which support energy efficiency and sustainability solutions beyond the initial planning and building phases and into the longer term of use and maintenance
- Efficiency can be enhanced at neighborhood and building levels through the application of advanced technologies. These measures need to be integrated into the energy supply systems of buildings and neighborhoods, from the level of a single building to the level of the broader urban context. These advanced technologies should be considered with an eye to the economic means of the users.
- The origin of vernacular urban form and its elements are not entirely discernable, nor are its characteristics always transferable to contemporary and advanced designs. But knowledge and reflection of its main aspects are essential for culturally adapted design solutions.
- Buildings create an artificial topography which impacts local climate.
- Beyond the recreation potential of open spaces, unsealed green or soil surfaces are also an important asset for natural cycles within modern urban environments. In combination with sustainable water management they serve as a resource for energy efficiency by helping to reduce outside temperatures.
- Low rise, high density urban design can promote energy efficient spaces.
- The spatial hierarchy addresses community and privacy, and is a central parameter for architectural design in the MENA region. The final step in this hierarchy is the absolute privacy of the individual home.

By the time this book is published the scientific debate will already have moved on. Hopefully this book will be part of the dynamic process of research, discussion, and innovation.

VIII
References, Figures, Tables, Acronyms, and Abbreviations



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List of Acronyms and Abbreviations

ALECSO	Arab League Educational, Cultural and Scientific Organization
AC	Air conditioning
Av.	Average
AWC	Arab Water Council
BauGB	Baugesetzbuch (German Federal Building Code)
BBSR	Bundesinstitut für Bau-, Stadt- und Raumforschung (The Federal Institute for Research on Building, Urban Affairs and Spatial Development)
BGR	Federal Institute for Geosciences and Natural Resources
BHRC	Building and Housing Research Center
BKI	Baukosteninformationszentrum (Building Costs Infomation Center)
BREEAM	Building Research Establishment Environmental Assessment Method for Communities
BRT	Bus Rapid Transit
CBD	Central Business District
CCME	Canadian Council of Ministers of the Environment
CHP	Combined Heat and Power
CIA	Central Intelligence Agency
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council)
DJF	December January February
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
DMA	District Metered Area
DoE	Department of Environment
DTM	Demographic transition model
DUF	The Danish Youth Council
DWA	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall E. V. (German Association for Water, Wastewater and Waste
DWD	Deutscher Wetterdienst (German Weather Service)
eia	U.S. Energy Information Administration
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EOR	Enhanced Oil Recovery
ETICS	External Thermal Insulation Composite Systems
FAO	Food and Agriculture Organization of the United Nations
GCI	Green City Index
GDP	Gross Domestic Product
GEF	Global Environment Facility
gha	Global hectares
GHG	Greenhouse gas
GIS	Geographic information system
CNG	Compressed Natural Gas
COP	Coefficient of performance
CW	Constructed Wetlands
$C0_2$	Carbon dioxide
giz	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Association for the International Cooperation)
GUIF	Global Urban Indicators Facility
HDI	Human Development Index

HDR	Human Development Reports
ICT	Information and Communication Technology
IDRC	International Development Research Center
iea	International Energy Agency
IEA-WI	Iran Energy Association—Wuppertal Institute for Climate, Environment and Energy
IEEO—SABA	The Iran Energy Efficiency Organization
IFCO	Iranian Fuel Conservation Company
IIEES	International Institute of Earthquake Engineering and Seismology
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Networks
IUCN	International Union for Conservation of Nature
IWWA	Integrated Waste Management in Western Africa
JJA	June July August
LEED-ND	Leadership in Energy and Environmental Design for Neighborhood Development
LRT	Light Rail Transit
MBR	Membrane bioreactor
MENA	Middle East and North Africa
MEP	Ministry of Economy and Planning, Iran
MHUD	Ministry for Housing and Urban Development, Iran
MoE	Ministry Of Energy, Iran
NTDC	New Town Development Cooperation
NWWEC	National Water and Wastewater Engineering Company
PT	Public Transport
ROPME	Regional Organization for the Protection of the Marine Environment
RSGA	Red Sea and the Gulf of Aden
SEA	Strategic Environmental Assessment
SMART	Sensitive, Measurable, Achievable, Relevant, and Time-bound
TJA	Tehran Justice Administration
UAE	United Arab Emirates
UN	United Nations
UNDESA	The United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UN-Habitat	United Nations Human Settlements Programme
VDI	Verein Deutscher Ingenieure (The Association of German Engineers)
WEC	World Energy Council
WHO	World Health Organization
WPM	Wind Power MENA
WWF	World Wildlife Fund
WWTP	Wastewater treatment plant
OBauB	Oberste Baubehörde im Bayerischen Staatsministerium des Innern (Supreme building authority of the bavarian ministry of the Interior)
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries

Young Cities Project Consortium

young cities
Developing Urban Energy Efficiency
Tehrān-Karaj

Technische Universität Berlin
Berlin, Germany

FIRST Fraunhofer Institute for Computer Architecture and Software Technology
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Road, Housing & Urban Development Research Center of Iran
(former Building and Housing Research Center, BHRC)
Tehran, Islamic Republic of Iran

Freie Universität Berlin
Berlin, Germany

New Towns Development Corporation
Tehran, Islamic Republic of Iran

inter3 Institute for Resource Management GmbH
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Iranian Ministry of Roads & Urban Development (MRUD)
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