Urban Switzerland

Authors

Peter Baccini, Chair	Professor emeritus at ETH Zurich
Fred Baumgartner	Urbanisation and Landscape, Federal Office for Spatial Development
Thomas Lichtensteiger	Urban Water Management, Eawag
Mark Michaeli	Institute for Urban Design, ETH Zurich
Esther Volken	Editor, ProClim–, Swiss Academy of Sciences

1. Introduction

Background

Switzerland is an urbanised country, that is, urban and rural areas are closely linked by dense flows of people and goods. It is this network, consisting of nodes and fluxes, that forms the urban system. The development of this system depends on numerous factors. Climate is just one of many cultural, political, economic, spatial and ecological factors. How strongly and in what way the expected climate change will affect settlement development, depends on the future form of the Swiss urban system. As a basis for the following assessment, three possible scenarios were chosen, for which the impact of climate change is described by means of six key factors:

1. Today's system as the reference state: CH_{today}.
2. A scenario based on the assumption that adaptations that have already been introduced will continue: $CH2050_{plus}$.
3. A scenario based on a change of policy according to the criteria of sustainable development: $CH2050_{eco}$.

The key factors are as follows:
1) Population
2) Settlement pattern
3) Building stock (inventory of buildings and infrastructure)
4) Transport and communications
5) Resources
6) Relationships within Switzerland and with foreign countries.

Overview

Population development will presumably be little affected by climate change. The change in the demographic structure will take place independent of climatic changes. Immigration pressure will probably increase if economic conditions worsen considerably in other countries due to climate change.

Settlement development will occur largely independent of climate change, except in mountain areas. These are under pressure to adapt due to the threat of natural hazards and the dependency on winter tourism. Settlement development in regions exposed to floods will be less affected.

The impact of climate change on *building development* is categorised as marginal. Here, the development depends primarily on the business cycle. Further substantial growth is expected by the mid-21st century.

The expected development of the *transport and communication* sector differs according to scenario. In the $CH2050_{plus}$ scenario, traffic will continue to increase, whereas in the $CH2050_{eco}$ scenario, the growth trend will come to a standstill. The $CH2050_{eco}$ scenario, with its changed settlement pattern with strengthened regional centres, will be less vulnerable towards climate change than the $CH2050_{plus}$ scenario.

Climate change will affect the *availability of resources* primarily with regard to the degree of self-sufficiency in food production and energy supply. In the $CH2050_{plus}$ scenario, the degree of self-sufficiency will decline for food and slightly increase for energy supply. In the $CH2050_{eco}$ scenario, a massive increase in the degree of self-sufficiency is expected for food and a small increase for energy supply.

The development of the *relationships with and dependencies on the global setting* are particularly decisive for the functioning of the Swiss urban system with regard to food and energy supply. Depending on the impacts of climate change on other regions, as well as global political changes, prices could increase substantially in both these sectors.

Altogether, the Swiss urban system as a whole is not endangered by climate change. Local and seasonal disturbances may be enhanced due to the impacts of climate change on other regions of the world. In comparison to the $CH2050_{plus}$ scenario, the $CH2050_{eco}$ scenario is more robust.

2. Switzerland as an urban system

Switzerland is an urbanised area that is influenced by cultural, political, economic, spatial and ecological factors. Thus, climate change represents just one of many factors.

Switzerland is a densely populated country with a mean population density of 180 inhabitants per square kilometre. The majority of the population lives in urbanised space, i.e. in a network that links urban and rural areas by strong flows of people, goods and information (fig. 1). This network, whose nodes (cities) are characterised by a high density of people and goods, is called an *urban system*. Thanks to this system, a high-quality of basic supply in Switzerland has been attained, and also a high level of security in the case of strongly varying environmental conditions (temperature, light, availability of resources) and natural hazards.

In Switzerland, urban forms of living have very different characteristics depending on the region. This is due to the fact that every urban development is shaped by the complex interaction of different factors, with cultural, political, economic, spatial and ecological factors determining settlement development. These factors can be external effects (exogenic, e.g., transport policy of the European Union, development of communication technology) or effects within the urban system (endogenous, e.g., business location decisions, development of gross domestic product). Global warming is therefore just one of many factors that affect the urban system. The strength of the impact on urban development depends on the regional characteristics and the development dynamics of the system concerned. These changes cannot be reliably predicted to the year 2050, although there are normative guidelines provided by the state (legislation, laws, regulations) and overall concepts from interest groups on how a country should look in 50 years. The following assessment is however not based on overall concepts but on scenarios. The climate scenarios for the year 2050, which show the expected change as well as the range of uncertainty for climate change, are applied to three possible scenarios of urban development in Switzerland (reference state CH_{today}, $CH2050_{plus}$, $CH2050_{eco}$, table 1). The questions that follow will be answered for each of these three scenarios.

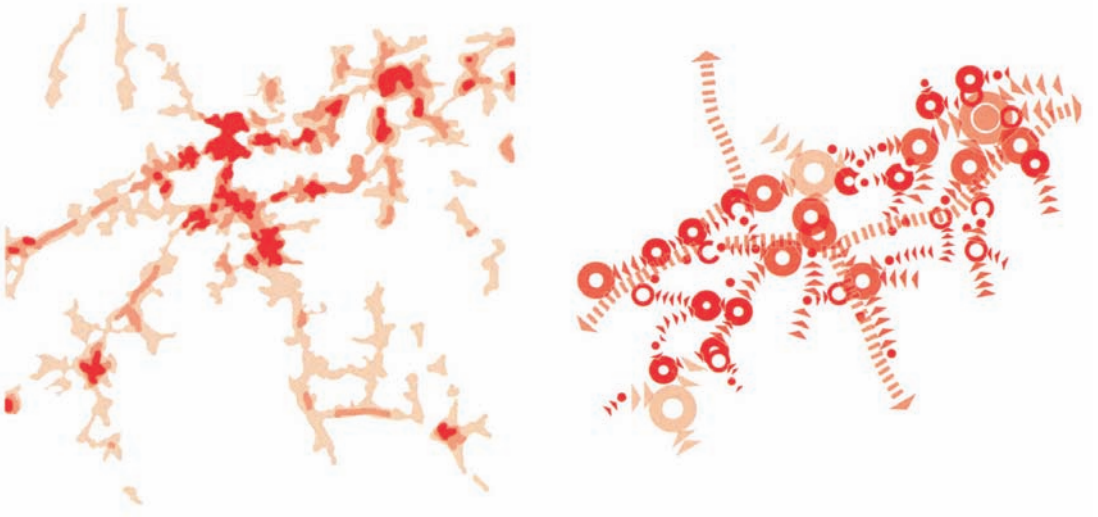

Figure 1: Graphic interpretation of the architecture of the territory according to the Netzstadt model:
- the web-like settlement structures and patterns (nodes and connections), using the midlands as an example (left)
- the fluxes (people, goods and information) within the web-like settlement structure, using the midlands as an example (right)

(Source: Oswald and Baccini 2003)[1]

In which areas is the urban system as a whole or part

a) robust, i.e. climate change is presumably irrelevant?
b) disturbed, i.e. adverse effects are possible but the functioning of the system as a whole is hardly at risk?
c) at risk, i.e. climate change endangers essential parts and therefore the system as a whole?

Other topics of the project "Climate change and Switzerland in 2050" are also considered to be subsystems of the urban system: Land ecosystems, Agriculture, Water management, Energy, Buildings and infrastructure, and Tourism (see corresponding chapters).

The majority of the following statements relating to the above-posed questions are qualitative. Quantitative statements are difficult because there are no reliable model results for urban systems. In contrast to the climate scenarios calculated with the help of physical models, the three urban development scenarios are based on six selected key factors: population, settlement pattern, buildings, transport and communications, resources, and relationships within Switzerland and with foreign countries. The impact of climate change in 2050 on the three scenarios of urban Switzerland is estimated by means of these key factors.

3. Scenarios and key factors

The impact of climate change on the Swiss urban system will be illustrated using the three scenarios. Today's state serves as the reference scenario. Scenario 2 describes a further development analogous to today's state, and scenario 3 is a change of policy towards sustainability (see table 1). Six key factors are used (see table 2).

Table 1: Possible scenarios of urban development in Switzerland up to the year 2050.

Scenarios	**CH_{today}** [1)]	**$CH2050_{plus}$**	**$CH2050_{eco}$**
Short description	Reference state, in order to estimate possible effects on today's existing system	Continuation of the development of the last decades, taking into consideration adaptations that have already been introduced	Change of policy according to the criteria of sustainable development[2)]

1) Relates to the year 2005, as far as numbers are available.
2) In the energy sector, this scenario has as its goal the 2000-Watt society, i.e. a reduction in energy consumption to one third of today's amount, as well as the extensive replacement of fossil fuel by renewable energy.

Table 2: Key factors for describing the urban system.

	Identifier	**Characteristics**
1	Population	population, age structure, ratio labour force/total population
2	Settlement pattern	population densities/distribution according to regions
3	Buildings	state and development of buildings and energy demand
4	Transport and communications	development of passenger transport and goods traffic, and of the communication sector
5	Resources	degree of self-sufficiency for basic resources such as water, energy, food, building materials
6	Relationships and interactions	domestic relationships: midlands vs. mountain areas; international relationships: dependencies on foreign countries

Possible changes in political institutions, such as the number and structure of administrative units (municipalities, cantons) and memberships in international bodies (e.g. European Union), are not taken into consideration. It is assumed that such changes are possible within both future scenarios ($CH2050_{plus}$ and $CH2050_{eco}$). Catastrophic economic, warlike and geologic incidents are not taken into consideration. Basic information on the scenarios chosen can be found in Baccini and Bader (1996)[2], Baccini and Imboden (2001)[3], Baccini et al. (2002)[4] and Leibundgut (2006).[5]

4. Population development

Quantitatively, the mean growth of the population will not present any new challenges. What will be important, however, are population aging and the reduced labour force. This will result in a change of spatially related utilisation demands.

Table 3: Parameters of population development[6]

Parameter	Scenarios		
	CH_{today}	$CH2050_{plus}$	$CH2050_{eco}$
Inhabitants (millions)	7.4	8.2[1)]	8.2[1)]
Old-age quotient[2)]	25	51	51
Overall employment rate[3)]	56	51	51

1) medium scenario (i.e. between 9.7 and 6.5 million)
2) old-age quotient: Number of people aged 65 and older per hundred people aged between 20 and 64.
3) overall employment rate: Number of people in the labour force per hundred people aged between 15 and 99.

The considerable change in the old-age quotient from 25% to 50% (Table 3) points to a shift in the age distribution, which will also mean drastic shifts in the framework of the social insurance system (old-age and survivors' insurance (AHV), company and private pensions, health care system). The inter-generation contracts established in the 20th century will most likely need to be strongly revised. The increasing ageing of the population should affect today's distribution and design of the living and working environment, as well as mobility, that is, today's building stock in Switzerland (see section 6) will also need to adapt to changed conditions and requirements.

The negative impacts of climate change mentioned in the Health chapter will probably have little effect on the population distribution. Climate change should also hardly have a strong influence on the change in the demographic structure. However, the possibility cannot be ruled out that immigration pressure will increase if economic conditions in other parts of the world take a long-term turn for the worse due to climate change.

Conclusion

A mean growth rate of the population of 0.3% per annum with a mean increase of the total population of about 14% will not quantitatively present any new challenges to the Swiss urban system. However, the shifts in the old-age quotient and overall employment rate will be important. These qualitatively grave changes in the demographic characteristics as compared to today will be highly relevant for future spatially related utilisation demands.

5. Urban development

Today, a large proportion of the Swiss population lives in cities and agglomerations. An important factor for the future development of the urban pattern is the steadily growing demand for settlement areas.

CH_{today}

In Switzerland, the settlement structure is considerably influenced by topography. Originally, settlements developed along waterbodies or commerce routes in the valleys and midlands and on the Jura plateau. They formed the points of origin for progressive settlement, which have since covered large areas all over the country with buildings and infrastructure. However, this urbanisation has not developed evenly throughout. Various factors, from industrialisation, the development of the railroad network, individual motorisation, and the development of air traffic to the modern means of communication, have contributed to the non-uniform development. With just a few exceptions, rapid increases in urbanisation were related to changes in lifestyle, very often in combination with changes in the areas of mobility and communication.

Particularly after the Second World War, economic growth led to an exponential settlement growth between the urban centres of the 19th century. This growth was not primarily caused by population growth but by the increasing demand for settlement area per capita and the increasing traffic area per capita. This process is still incomplete even now at the beginning of the 21st century. In about thirty years (1950–1980), the number of motor vehicles for passenger transport had increased tenfold. Lifestyle changed as a result of high individual mobility.

Today's urban structure thus generated is called Netzstadt and integrates areas used for agriculture, forestry and water management (fig. 2). In the midlands, the actual proportion of the settlement area is between 10 and 15% of the total area. Agriculture accounts for about half of the total area, and forests one-third. Considerably more than 75% of the Swiss resident population live and work in cities and agglomerations.[7] This shows that accessibility, development and the vicinity of urban attractions are particularly important criteria for the choice of where to live and work.[8] The development of real estate prices in the large agglomerations of Zurich and the Lake Geneva area reflects these preferences. Increasingly, areas are built on and settled that were little favoured as locations up to now. This statement is true for all of Switzerland but to an even greater extent for the urban areas in the pre-alpine and alpine regions.

There are tourist locations in the alpine region that have experienced strongly accelerated urban development that is particularly related to the expansion of winter tourism. Here in the past, it was assumed that the climate would remain constant, thereby ensuring reliable snow conditions (fig. 3).

Figure 2: Large-scale photograph with Kloten, Wallisellen, Opfikon, Hard (2004): The web-like structure between the municipalities is clearly visible (Source: Swiss Air Force).

Figure 3: View over Lake St. Moritz to the village St. Moritz (south-east elevation), the mountain range with Piz Nair, Sass Runzöl and Las Trais Fluors in the background, general view, reconstructed photo, in 1899 (above) and 1996 (below).
(Source: Stiftung documenta natura, Bern)

$CH2050_{plus}$

If the population development in table 1 is combined with the still steadily increasing urban area per capita of today of 400 m^2 per capita to about 470 m^2 per capita by 2050 (growth rate up to now: about 1.3. m^2 per capita and annum, see fig. 4), a total increase in urban area (i.e. with the land-use demands for the proportional increase in infrastructure requirements) of about 30–40% is to be expected. In this scenario, this growth will certainly be larger than the potentially decreasing demand for workspace due to the lower employment rate. Though the additional demand for settlement area is already nominally covered with regard to today's designation of building zones, the regional distribution does not conform to the demand or the targets of spatial planning. In the $CH2050_{plus}$ scenario, there will be too little high-density housing built in already existing settlement areas due to the absence of or false incentives. The settlement pattern represented in the CH_{today} reference state will therefore be further strengthened, that is, existing nodes and links will be enlarged in area, in fact by about 30%. In the midlands, the proportion of settlement area would increase to about 15 to 20%, at the expense of the most productive agricultural land in Switzerland, of which the total area would decrease by about 10%.

This development will be different in different regions, due to the economic advantages of location of large agglomerations, and the availability of infrastructure and real estate. The densely populated urban areas of the midlands, the region around the border triangle of Basel, the lake Geneva area and Ticino, which is strongly shaped by the development in upper Italy, will be particularly affected by the increasing demand for settlement area. It can be assumed, furthermore, that in the mountain areas of Switzerland, as well as of other parts of Europe, the demand for holiday homes will increase due to the desire for summer retreat (see Tourism chapter, section 6).

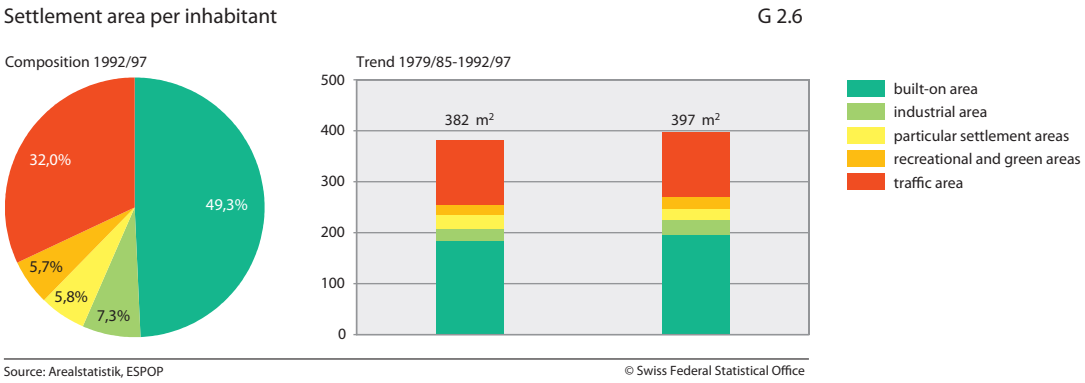

Figure 4: Land-use statistics divide the urban area into five kinds of use: built-on area, industrial area, traffic area, particular settlement areas, and recreational and green areas. The built-on area dominates the settlement area with a proportion of almost 50%.
(Source: Arealstatistik Schweiz, Zahlen – Fakten – Analysen, Federal Office for Statistics BFS, 2005)

$CH2050_{eco}$

An urban settlement structure that conforms to the criteria of sustainability offers more varied design possibilities compared to today's settlement patterns. According to the quality targets of the Netzstadtmodel[1], the existing pattern will need to be revised or adapted with regard to the following areas: The effectiveness of the spatial planning instruments (federal plans, cantonal directive plans, municipal zoning plans) needs to be even more strongly adjusted to the targets of the entire spatial development (spatial concept Switzerland) and the imperative of economical land use and well-regulated settlement development.

- With a strengthening at the regional level, the possibilities for satisfying material and non-material needs must be improved. In this way, the quality of life can be maintained or even increased in spite of a decrease in traffic volume.
- On the national level, the trend towards further spatial expansion of the large agglomerations must be stopped. Strong regional centres of different quality will mean more diversity and therefore a more robust Swiss urban system.
- If agriculture, forestry and water management are carried out according to sustainability criteria, smaller earnings in comparison to today are partly to be expected (about 10%), which, however, can be compensated by other measures (see sections 6, 7 and 8).

These adaptations in settlement development would lead to considerable structural improvements on the regional and municipal level.[1] On a national level, the basic structure of the settlement pattern would still not change substantially.

Conclusions

Altogether, the effects of climate change on urban development to 2050 can be considered to be rather small. Vulnerability will be highest in the alpine area, which strongly depends on tourism (see Tourism chapter, section 4), and for buildings and facilities of the rail and road networks, which are particularly exposed to natural influences. Settlement areas that are located in the immediate vicinity of waterbodies will also be affected to a limited extent. It can be expected, however, that the adaptations that are continuously being implemented due to the increased danger potential that is already recognised today (e.g. building restrictions based on risk maps, expansion of watercourses, local shifts in settlement development) will be successful. Altogether, the potential for conflicts between the demand for land for settlement development and other (utilisation) interests will be smaller for the $CH2050_{eco}$ scenario because the aim is a concentration of existing nodes and connections, rather than a further expansion in land use.

6. Development of building stock

If climate change is consistently and anticipatorily taken into consideration for renovations and new buildings, the impact of climate change on the Swiss building stock will be marginal.

The parameters for the Swiss building stock are compiled in table 4.[9]

Table 4: Stock and energy flux of the Swiss urban system.

	CH_{today} [1)]	$CH2050_{plus}$	$CH2050_{eco}$
Stock in tons per inhabitant[2)]	400	500	450
Energy demand in watts per inhabitant[3)]	6000	6000	2000

1) reference year 2000
2) comprises buildings and infrastructure
3) includes the energy brought in with imported goods (embodied energy)

Today's building stock corresponds to a replacement value of about half a million Swiss Francs per inhabitant. In the $CH2050_{plus}$ scenario, this stock will increase by about one quarter. From an economic perspective, this means that the generation after the next will have to generate more capital per capita in order to ensure the conservation of value of its real estate. In the $CH2050_{eco}$ scenario, growth will be smaller because infrastructure is optimised (see section 5) and passenger transport is strongly shifted to the railway system. Thereby, the increase in civil engineering will be smaller. With regard to energy demand in the $CH2050_{plus}$ scenario, the measures already taken (e.g. building regulations, taxes on fossil energy sources, promotion of renewable energy) will result in an approximate compensation of the increasing demand by increased energy efficiency. In the $CH2050_{eco}$ scenario,the focus will be on a consistent modification of energy technology in combination with the systematic adaptation of building and transport technology. This scenario aims at reducing the proportion of fossil energy sources in today's primary energy demand of about 5500 watt (including nuclear energy sources) to about 500 watt per inhabitant.[10] The adjustment of the energy budget, which is determined to 80% by living and working activities, transporting and communicating (see section 7), will be the key process in this scenario.[3]

Conclusion

The impact of climate change on the Swiss building stock will be marginal for both scenarios, provided that climate change is taken into consideration for renovations and new buildings (see Buildings and infrastructure chapter, section 2). In highly developed countries, the development of the building stock depends on the economic cycle, that is, the higher the economic growth in the most important branches of value creation, the more active the building activity. However, this framework can be changed by means of political regulations and incentives in such a way that the effects of new environmental influences (e.g. climate change, availability of resources, traffic congestion, traffic noise burden) can be identified at an early stage and reduced in the name of prevention, if reasonable.

7. Development in transport and communications

Disruptions to traffic routes and long-distance power lines may possibly increase with more frequently occurring extreme events. An ecologically oriented development reduces the sensitivity through concentrated nodes and lower energy consumption.

CH_{today}

In the past decades, the transport of passengers, goods and information has gradually increased, as measured by distances covered per capita and per annum (see fig. 5). Passenger transport accounts for the largest proportion (70 to 80%), while information flow amounts to just a few percent. Transport is the most important factor with regard to atmospheric and noise load. Up to now, the reduction targets could only partly be met in spite of engineering (e.g. catalysers for combustion engines) and construction (e.g. noise barriers) measures.

$CH2050_{plus}$

The increasing number of vehicles per capita and kilometres covered per vehicle and annum will increase the negative effects on the environment (air, noise) and the economy (congestion costs). Though traffic congestion can, with a time lag, be solved locally by means of road extension projects, it will be shifted to other bottlenecks within the Swiss Netzstadt. The expansion of metropolises and the increase in private passenger transport will reinforce each other. Although the expansion of public transport can reduce the growth of individual motorised traffic, it cannot solve the related problems that already exist.

$CH2050_{eco}$

In contrast to the $CH2050_{plus}$ scenario, the traffic growth trend will come to a standstill in the $CH2050_{eco}$ scenario.[11] Inward settlement development and strengthening of the regional centres will mean that the distances covered become shorter because they are matched to the appropriate activity (e.g. working, shopping, recreational activity). However, these changes will only be realisable with a reorganisation of the Netzstadt, that is, the entire settlement pattern (see Netzstadt model by Oswald and Baccini[1]) and not with purely traffic-related measures.

Conclusion

Climate change will not have a significant impact on transport and communications because the problems related to these areas little depend on external influences. An exception is the energy supply (see sections 8 and 9) and the interruption of traffic routes due to extreme weather events. The vulnerability with regard to interrupted traffic routes will be smallest for the $CH2050_{eco}$ scenario, due to concentrated nodes.

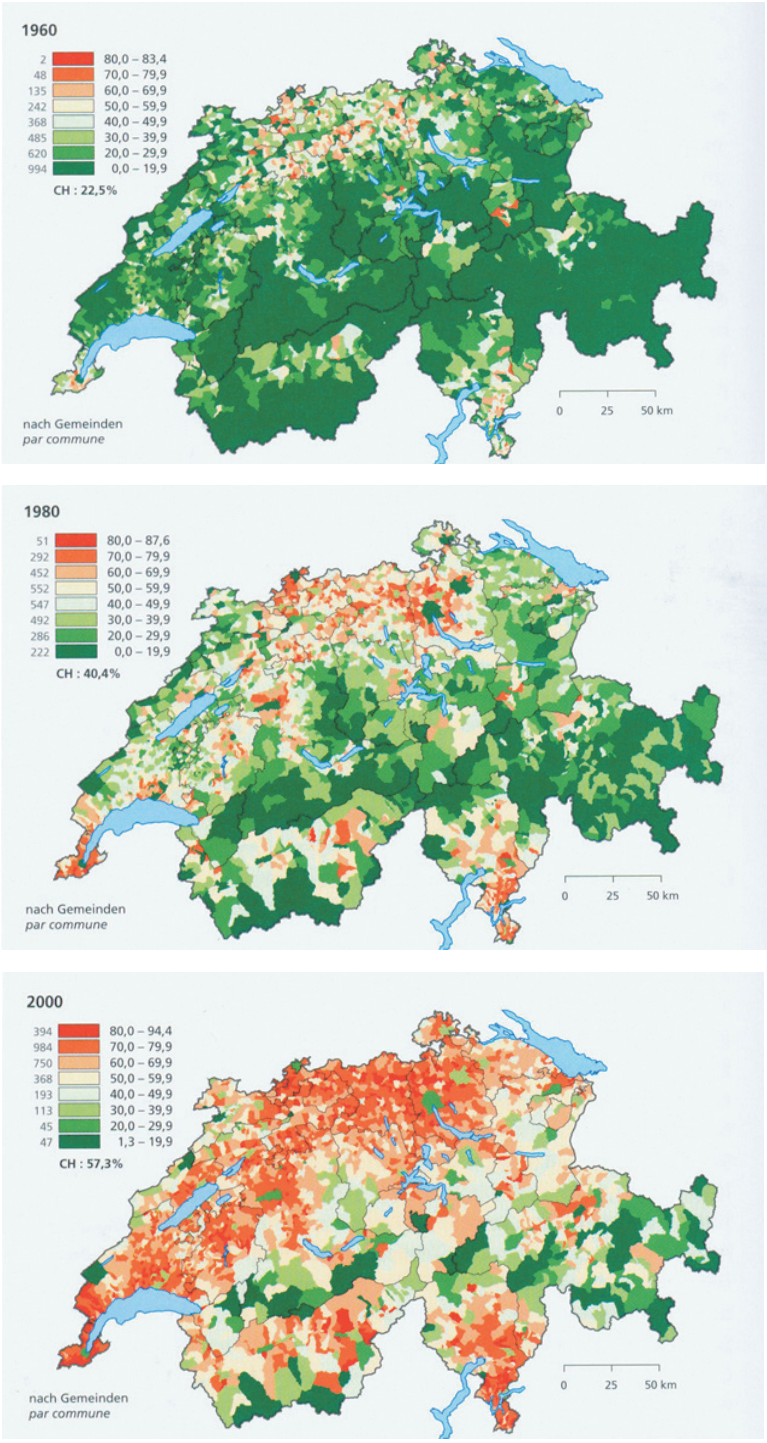

Figure 5: Development of commuter flow between 1960 and 2000: The proportion of the labour force working outside their municipality of residence (in %) is mapped for 1960, 1980 and 2000, respectively.

Green areas correspond to a small proportion of the labour force working outside their municipality of residence (<40%). Red and orange areas correspond to a proportion of 60% or more of the labour force working outside their municipality of residence.

Proportion of commuters:
1960 CH: 22.5%
1980 CH: 40.4%
2000 CH: 57.3%

(Source: Schuler, Martin et al. Atlas des räumlichen Wandels der Schweiz, Bundesamt für Statistik, Neuchâtel und Verlag Neue Zürcher Zeitung, 2006. S.268)

8. Development of resource availability

The Swiss urban system is most strongly at risk due to the non-sustainable energy supply. As a global phenomenon, climate change increases this risk because other regions are also affected.

Table 5: Resource availability of the Swiss urban system shown by means of a theoretical degree of self-sufficiency.[2] The theoretical degree of self-sufficiency describes the ratio (in mass or energy units) of the total domestically produced amount (in %) to total consumption, i.e. import and export are offset against each other as exchangeable components in the point balance. In view of the variation in quality, this is a strong simplification. Thus, the numbers are to be understood as orders of magnitude only.

Resources	Scenarios		
	CH_{today}	$CH2050_{plus}$	$CH2050_{eco}$
Water	100	100 (seasonally and regionally disturbed)	100 (seasonally and regionally disturbed)
Biomass	60 (food) 100 (wood)	40 (food) 100 (wood)	80 (food) 100 (wood)
Building materials	90	70	100
Energy sources	10	20	90

CH_{today}

In the CH_{today} scenario, the Swiss urban system is autonomous with the already existing water supply infrastructure. For bulk materials of the building sector (gravel, sand, clay), which account for almost 90% of the overall mass of the building stock, the theoretical degree of self-sufficiency (DSS) is high. Forestry legislation requires sustainable forest management. For economic reasons, forests are only used to about 70% today. Extreme events, such as storms leading to forest damage, result in local disturbances and lead to a temporary oversupply of wood. In the food industry, the DSS of 60% is primarily a consequence of the population's diet, that is, the higher the meat consumption, the lower the DSS. With regard to energy supply, DSS is the lowest because the urban system in the 20th century was consistently oriented to fossil sources in the global market. There, the DSS is presently at 10%, of which the main part is provided by the use of water power for electricity production.

$CH2050_{plus}$

For the $CH2050_{plus}$ scenario, the picture will remain largely the same. According to the Water management chapter, climate change can lead locally and seasonally to bottlenecks in supply (see Water management chapter, section 4). In the food industry, DSS will decrease because the continuation of agricultural policy will force producers to compete in the unprotected market by means of niche products. Increases in energy consumption efficiency that have already been introduced and investments into water power, solar sources, geothermal and wind power could increase DSS to 20%. This development will be influenced by climate change because reduced water supply is to be anticipated in the future (see Water management chapter, section 4).

$CH2050_{eco}$

In the $CH2050_{eco}$ scenario, DSS will increase for all four resources considered. For food, this will happen under the assumption that the regional supply will improve overall (see Agriculture chapter, section 2) and that, in addition, diet will change so that meat consumption per capita decreases. For building materials, DSS increases due to the wide-spread use of the new technology of "urban mining"[9], i.e. the recovery of raw materials from existing building stock. The energy sector will experience the greatest change, with DSS increasing massively (see also section 7). In the water power sector, climate change will impede this development due to the already mentioned

reduction in runoff. On the other hand, climate change is a reason for an energy supply as low in CO_2 emissions as possible. Altogether, also in this scenario, the availability of resources primarily results from the politically and socio-economically shaped development.

Conclusion

The degree of self-sufficiency for food and energy will change for both scenarios. In contrast to the $CH2050_{plus}$ scenario, the degree of self-sufficiency in the $CH2050_{eco}$ scenario can be expected to increase slightly due to improved regional supply and altered diet. In the energy sector, the degree of self-sufficiency will increase more strongly in the $CH2050_{eco}$ scenario. On the one hand, climate change will affect this development by the change in water resources, and on the other hand, indirectly as a driving force behind the decarbonisation of the energy supply system.

9. Development of relationships and dependencies between the Swiss urban system and the global environment

Climate change is a global phenomenon. The Swiss urban system will therefore not only be affected directly but also indirectly as a result of the impacts on other parts of the world.

The proportion of income that households spend on food and energy is a critical factor with regard to the future functioning of the Swiss urban system. If this proportion is also smaller than 20% in the future, the availability of resources will presumably correspond to the numbers in table 5. However, there are climate change scenarios for other regions (subtropical, arid) in which the production of agricultural goods will decrease massively due to the changed water supply. As a result, the price for food will increase exponentially and also substantially change the household budget in Switzerland. The availability of energy from fossil deposits will hardly change as a direct result of climate change. However, should energy prices increase rapidly because of global political changes, the Swiss urban system does not yet have an alternative supply possibility. In this case, the prices could reach very high levels in countries with a low degree of self-sufficiency, i.e. level out within 10–20 years at the tenfold amount. On the other hand, the reconstruction process of the building stock (see section 6) for a $CH2050_{eco}$ scenario would take 30–60 years. Not until then would Switzerland be ready for such a situation.

Conclusion

From today's global political perspective, the Swiss urban system is most strongly affected by the non-sustainably oriented energy supply. This disadvantage may even increase, depending on the impact of global climate change on other regions.

10. Conclusions

When considered in isolation, the Swiss urban system is relatively robust with relation to climate change. A fundamental reconstruction towards targeted sustainable development will minimise the direct and indirect consequences.

For all three scenarios outlined, it can be said that the effects of climate change may disturb the Swiss urban system locally and seasonally (see conclusions of other chapters) but will not put it at risk as a whole. Thus, the system is relatively robust. If Switzerland develops towards the $CH2050_{plus}$ scenario, climate change will only slightly affect the handling of the deficiencies of the urban system. The non-sustainable energy supply (one-sided dependency on fossil energy sources), as well as the increasing building stock per capita (exponential increase in operating costs), will remain. The impact of climate change on other regions that are economically relevant to Switzerland could even increase these weaknesses.

The $CH2050_{eco}$ scenario shows the characteristics that the Swiss urban system should have in order to eliminate its weaknesses. As a small sovereign society, Switzerland would be – so to speak as a bonus – more robust to the direct and indirect consequences of climate change. Reconstructing Switzerland towards a $CH2050_{eco}$ state would require broad political support. Up to now, such a reorganisational process has only been an issue within a few academic groups, while in the political programmes of the Federal Council and the parliament, it is only in the modest beginning stages and is still far from implementation. From today's perspective, it therefore seems to be more likely that the Swiss urban system will continue to move towards the $CH2050_{plus}$ scenario.

Literature and notes

1 F. Oswald, P. Baccini, in Zusammenarbeit mit Mark Michaeli. Netzstadt – Einführung in das Stadtentwerfen. Basel/Boston/Berlin: Birkhäuser Verlag für Architektur, 2003.

2 P. Baccini, H.-P. Bader. Regionaler Stoffhaushalt. Heidelberg: Spektrum Akademischer Verlag, 1996.

3 P. Baccini, D. Imboden. Technological strategies for reaching sustainable resource management in urban regions. In: Our fragile world: Challenges and opportunities for sustainable development. Forerunner to Encyclopedia of Life Support Systems. Oxford: EOLSS Publ., 2001, 2153–2173.

4 P. Baccini, S. Kytzia, and F. Oswald. Restructuring urban systems. In: F. Moavenzadeh, K. Hanaki, P. Baccini (Hg.). Future cities: dynamics and sustainability. Kluwer Academic Publishers, 2002, 17–43.

5 H. Leibundgut. Low-Ex-Gebäude ohne Verbrennungsprozesse. Einführungsvorlesung an der ETH Zürich vom 29.5.2006, Archiv der ETH Zürich.

6 Bundesamt für Statistik (BfS). Szenarien zur Bevölkerungsentwicklung 2050. Bern, 2006.

7 Bundesamt für Raumentwicklung ARE. Raumentwicklungsbericht 2005

8 M. Michaeli. Abschnitt „Netze". In: T. Sieverts, M. Koch et al. Zwischenstadt entwerfen, Zwischen Stadt entwerfen. Wuppertal, 2006.

9 Th. Lichtensteiger (Hg.). Bauwerke als Ressourcennutzer und Ressourcenspender in der langfristigen Entwicklung urbaner Systeme. vdf Zürich, 2006.

10 Based on the requirement that the climate should be stabilised and that every person in the world may emit the same amount of CO_2.

11 Ch. Blaser, M. Redle. Mehr Mobilität mit weniger Verkehr – Umbauszenarien zur Aktivität Transportieren und Kommunizieren. In: P. Baccini, F. Oswald (Hg.). Netzstadt – Transdisziplinäre Methoden zum Umbau urbaner Systeme. vdf Zürich, 1998.