EFFECTS OF FUTURE CITY DEVELOPMENTS – DEVELOPMENT SCENARIOS OF MUNICIPALITIES


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Summary

The Leibniz Institute of Ecological and Regional Development (IOER) developed a scenarioable model for the analysis and calculation of building material and area quantities of the residential building stock as well as the associated energy and emission characteristic values. Relevant area, material and energy characteristics for the status Quo and for possible future developments of the residential building stock can be analysed with this model. Particularly for East German cities with population loss, information on land use, brown fields development and expenditures for houses and infrastructure are very important.

Keywords: Residential building stock, status Quo and possible future developments, scenarioable calculation model, building material for houses and infrastructure, new land, brown fields

1 Introduction

The building stock model was tested in two East German medium sized cities. Scenarios for 2020 for the residential building stock and its infrastructure were modelled and ex ante analysed. Key indicators were the use of land and building material as well as the heating demand. The investigations show that the future housing demand can be realized in different ways of land use and different building types. The relation between housing loss (demolition of dwellings, merging of existing dwellings), housing increase (new building, building activity in the stock) and development of vacancies (reduction of vacancies, increase of vacancies) as well as the use of brown fields in the city is especially important.

Because cities asked of anonymization, the results are presented by a fictitious city with 250.000 inhabitants and an expected decrease in population from 15 % to 2020.

2 Development scenarios

The housing stock consists of many different buildings, which can be described by building types. Building types are groups of buildings with specific age and structure. Of the multi-family houses the two larges groups are the old buildings until 1918 and the prefabricated buildings from 1971 to 1990. In 2001 25 % of the total housing stock (dwellings) in the investigated cities was vacant.

Until 2020 the housing demand will continue to decrease. Especially in the large residential areas with prefabricated housing the decrease of housing demand will be high. In contrast to the dwellings, there will be a growing demand for single-family houses.

The prognosticated housing demand can be realized in different building types and age groups. Therefore a reference and a change scenario were set in dialogue with town planners and ex ante analyzed. Key assumption:

The **reference scenario** reflects the most probable development. For new building it's assumed that 20 % are built on brown fields, 30 % on building gaps and 50 % on new land ("green field"). The proportion between single family homes and MURB's (Multi Unit Residential Buildings) is 50/50. The demolition activity per year amounts to approx. 1 % of the residential building stock. Until 2020 the vacancy ratio will sink by around 5 % (**Tab. 1**).

Tab. 1 Scenario acceptances

	Va-cancy	**Demo-lition until 2020**	**New building until 2020**	**New building – one-, two- and multi-family houses**			**New building – one- and two-family houses**	
				Brown fields	**Buil-ding gabs**	**New land**	**Single- and douple-houses**	**Terraced houses**
Reference scenario	Reduc-tion of **5 %**	**21 %** of the stock 2001	**5 %** of the stock 2001	20 %	30 %	50 %	50 %	50 %
Change scenario	Reduc-tion of **12 %**	**27 %** of the stock 2001	**7 %** of the stock 2001	50 %	30 %	20 %	33 %	67%

In the **change by scenario** the decrease of vacancy is clearly stronger. Vacancy sinks until 2020 by 12 % to a ratio of 13 %. In the context of new building construction the use of brown fields and compact urban structure types have a high priority. Demolition is financially supported by the state and every year 1.3 % of the residential building stock will be demolished.

2.1 Demolition waste

The quantity of demolition waste depends on the assumed demolition ratio. The quantities of demolition were calculated for different building types along the urban structure types with specific area, material and energy values. As result the quantity and the kind of the demolition waste can be computed. The change scenario has more demolition waste as the reference scenario. In the change scenario altogether 980 tons per day must transported out of the city. In the reference scenario it will be 700 tons per day (**Fig. 1**). The change

scenario produces a higher amount of brick gavel, because the building age group until 1918 will loose greater quantities as in the reference scenario.

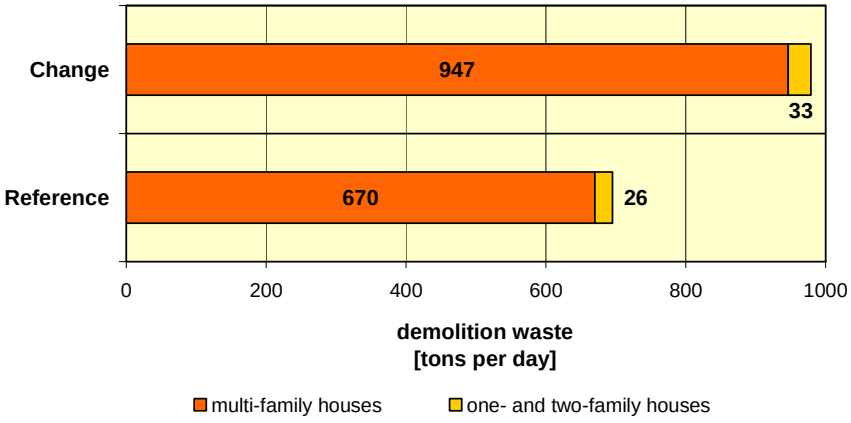

Fig. 1 Demolition waste – comparison between reference and change scenario

The demolition of buildings produces not only demolition waste, but also new brown fields. In the reference scenario an average of 20.8 hectares per year will be “set free” by demolition. In the change scenario there are even 30.6 hectares per year because the demolition activity is higher (**Fig. 3**).

2.2 Surface of the city

Another result is the shrinking surface of the city (**Fig. 2**). Surface compiles green space, roads, building fassades and roofs.

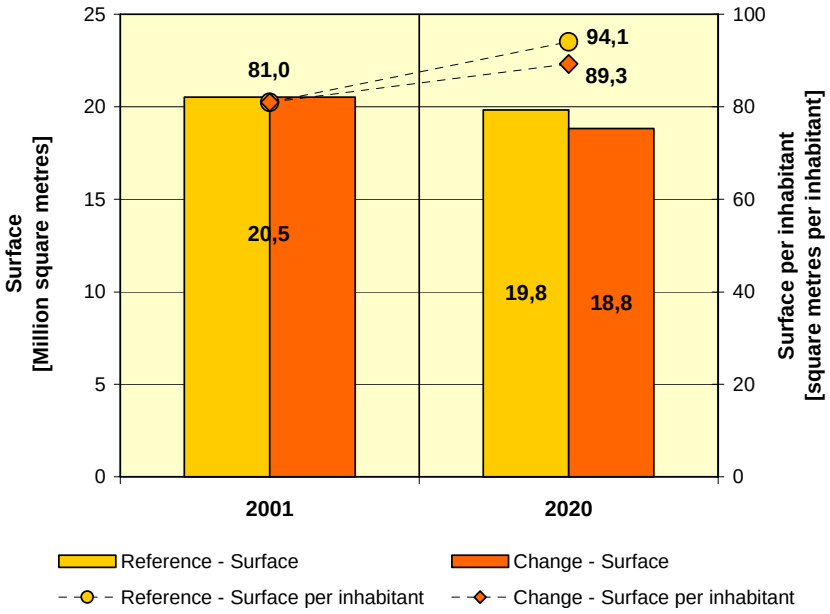

Fig. 2 Changes of the cities surface – comparison between reference and change scenario

Because of the planned demolition activity the surface of the city in absolute towns will shrink. In contrast to this the surface per inhabitant rises. In 2020 an inhabitant will "use"

a surface of 94.1 square metres (reference scenario). In the change scenario the surface will amount to 89.3 m². All in all in shrinking cities the surface per inhabitant and therefore the thermal envelope will rise around 10 to 15 %. If vacant buildings are not demolished, this consumption will clearly be even higher, due to the fact the inhabited volume will look like "swiss chease".

2.3 Land use by new building

Despite demolition necessities there will always be new construction. Depending where (brown fields, building gaps, new land), what (one- and two- or multi-family houses) and how/urban structure type (blocks, linear development, single building) building activities happen, land use as well as material expenditures for buildings and infrastructure will differ.

In the change scenario the higher ratio of new building activities on brown fields results in a reduction of **total** gross land area by 5 %, the reference scenario shows an increase of 5 %. If one looks only at the **new land**, there is a high reduction potential in the change scenario 65 % (**Fig. 3**).

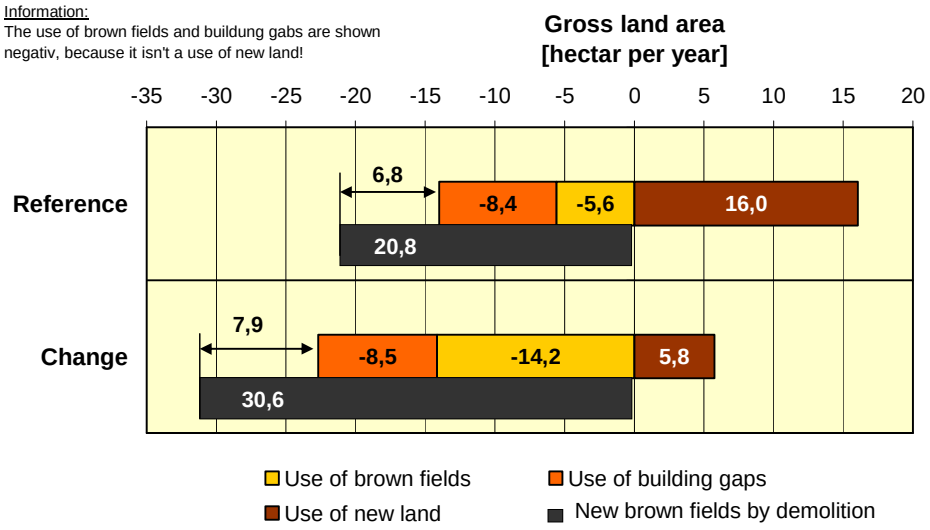

Fig. 3 Use of gross land area by new building – comparison between new land and brown fields

Both scenarios show in principal similar developments.

In both scenarios the demolition land area potential is higher than the land area demand calculated for new building on brown fields and building gaps. In the reference scenario the difference amounts 6.8 hectares per year. In both scenario brown fields will grow every year. In 2020 the brown field area will have 130 hectares. In the change scenario it is even higher because there is a higher demolition activity assumed. The difference amounts to 7.9 hectares per year and will grow to 150 hectares in 2020. The use of total brown fields becomes an important action field of the urban development. Here the municipal politics must develop strategies and regional as well as national politics should support inner development (brown field).

2.4 Material consumption by new building on new land

The construction of new dwellings (one-, two- and multi-family houses) on new land ("green field") needs new infrastructure (roads, ways, lines for drinking water and waste water). This fact has not only effects on the use of land and the consumption of material, but also on the financing of the municipality because municipalities have to pay for the maintenance of infrastructure (**Fig. 4**).

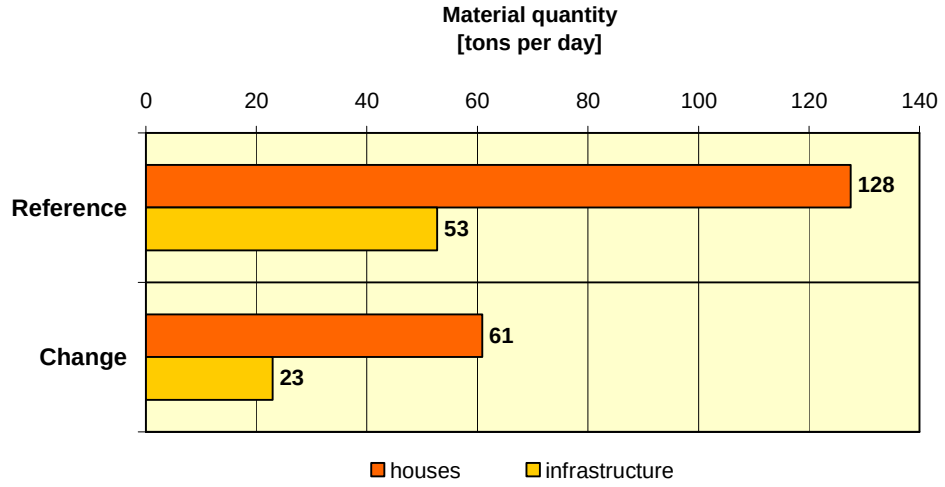

Fig. 4 Material consumption by new building of houses and infrastructure on new land – comparison between reference and change scenario

In the reference scenario 53 tons per day building material are necessary in order to provide one- and multi-family houses with technical infrastructure until 2020. In the change scenario only 23 tons per day building material are needed, because the new building activity on new land ("green field") is smaller. In both scenarios the material consumption for the technical infrastructure amounts approximately to 40 % of the material flow needed for the residential buildings itself. If the planned new building are realized in single-family houses with small building density the material consumption for the technical infrastructure can even rise to 75 % of the material flow necessary for the residential buildings.

Although brown fields and building gaps are connected to the technical infrastructure net, nevertheless adaptations are necessary in order to allow new one- and multi-family houses to be constructed. It means, material consumptions will occur (in the figure not represented), but the material consumption is not so high as the material flow for development of new land.

3 Conclusions (Summary)

Future developments of housing demand can be illustrated on urban structural level in form of different inventory scenarios. For municipalities, which are affected by decrease in population, information about land use (new land, brown fields, building gaps), growth of brown fields and expenditures of infrastructure is very important. The results presented apply for a city of 250.000 inhabitants and population loss of 15 % until 2020.

On basis of the calculated demolition activity – a fifth (reference scenario) up to a quarter (change scenario) of the residential building stock 2001 will have to be demolished until 2020 – the demolition waste ranges from 700 to 980 tons per day.

New brown fields are a result of the calculated demolition activity. Even if most of these areas are used for new building activities, brown fields will grow between 7 (reference scenario) up to 8 (change scenario) hectares per year until 2020.

To concentrate new building activities on brown fields and building gaps is a must. The change scenario shows that the use of **total** gross land area can be reduced by 5 %. The use of gross land area of **new land** (“green field") can sink by 65 % in comparison to the reference scenario.

If the new building activities are realized on new land (“green field") the material consumption for the technical infrastructure might amount to 40 % of the material flow for the residential buildings itself.

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