Abstract

Rwanda is not only one of the smallest countries in Africa, but also has the highest population density on the continent. A large part of the population lives on subsistence farming, therefore dispersed settlements and strongly fragmented agricultural areas are characteristic for the cultural landscape in large parts of the country such as in the district of Nyanza. Due to an administrative reform Nyanza has been the capital of the new South Province since 2006. Therefore the municipality is faced with numerous tasks in settlement and urban planning because of its grown importance and the thus required new space for administration, commerce, and additional residential areas. Based on the fact of a high population pressure with an annual population increase of 2.76% and a high exploitation of the existing environment, e.g. as the pollution of important water resources due to unpurified waste water, the threat of deforestation as well as danger of erosion of precipices because of uncontrolled settlement activities, new urbanisation patterns and strategies for transformation processes will be developed and implemented. Innovative technologies for telecommunication, water catchment and energy generation can support additional, more decentralised settlement concentration with decentralised work and farming opportunities on the basis of the existing settlement structure and vernacular housing principles. The urbanisation of historically grown cultural landscapes could create a new type of settlement that is a future-proof model regarding sustainability and resource conservation, particularly in a process in which cities are increasingly disintegrating and rural areas are becoming more and more urban.2

New lessons learnt from previous research

"Confronting the challenges of rampant urbanization demands integrated, multidisciplinary approaches, and new thinking........It may seem utopian to promote these innovations in the emerging and developing world, many of whose inhabitants can barely afford a roof over their heads. But those countries have already shown a gift for technological fast-forwarding, for example, by leapfrogging the need for landline infrastructure to embrace mobile phones. And many poorer countries have a rich tradition of adapting buildings to local practices, environments and climates - a home-grown approach to integrated designs that has been all but been lost in the West. They now have an opportunity to combine these traditional approaches with modern technologies."3

This quotation by Mike Davis describes best the contents as well as the methodic proceedings which are relevant in the described research project.

1 This paper relates to the research project „urban and settlement planning in Nyanza - Rwanda“, project-manager Astrid Weisel, Chair for rural Urbanism and Territorial Architecture in cooperation with Chair for Climatic Design and Building Services, Chair of Strategies for Landscape Management
2 http://www.urbanlandscape.ar.tum.de/07_startX.html [04.04.2010]
Urbanisation of landscape as opposing model to the traditional city

Especially in cities in the South and emerging nations, the number of large cities and megacities has increased severely, a development caused both by rural poverty and the attraction of booming urban economies. Uncontrolled urbanization followed by the emergence of slums with their negative effects on ecology, society, health and infrastructure is a well known and often discussed problem. The forecasted increase of rural population, however, does not attract much interest. This is particularly important regarding the increase in population to nine to ten billion people within the next fifty years as predicted by the United Nations. The Earth will thus reach its maximum capability regarding its natural resources like soil, water and energy.

Compact city systems are generally considered to be spacesaving and therefore sustainable even though a majority of raw materials has to be imported and later on exported as waste. In contrast, can rural areas with dispersed settlement structures and based on decentralised circulation models provide a future-proof model of urbanisation in terms of sustainability and resource conservation? Urban densification could make use of a historical grown landscape’s potential, as well as most of the population’s livelihood could be maintained. It is a likely conception that by use of innovative communication technologies and an area-wide upgrading of ITC-infrastructure the so far common principles of urbanisation will take a course totally different from the industrial nations’ history and that a new type of settlement will be created. Here, the relation of farming to settlement structure plays an important part.

A study presented by the United Nations particularly shows agriculture as an instrument of the circular flow economy. Instead of consuming resources and food and leaving them as waste (>open loops<), recycling models shall be developed with the aid of agriculture, which reduce the demand in raw materials and waste production (>closed loops<). The close connection between agriculture and housing additionally provides space for concepts of living that are based on self-production and informal economic concepts. These are qualities outside the tangible system of values that will also gain importance again for the western world dominated by the division of labour and economic growth.

Approach to the research theme urban land scape
The project is closely linked to the cluster of research urban land scape within the department of Architectural Design & Urban and Landscape Planning of Technische Universität Stuttgart 2005.

[fig. 1] United Nations Development Programme: agriculture as the instrument of a circular flow economy

4 Worldwide, the rural population has reduced from 80 per cent in 1950 to 50 per cent today; however, it increased from 1.5 billion to around 3 billion in absolute figures.
5 Eckhart Ribbeck: Die Welt wird Stadt, Stadtbilder aus Asien, Afrika, Lateinamerika (Stuttgart 2005)
Universität München, which deals with the study and reassessment of dispersed structures as well as with current issues of different aspects of city landscapes. Since the contrast between city and countryside is disappearing all over the world, formerly rural areas are developing into a new type of settlement, the “landscape city”. This new type cannot be described in conventional terms of landscape, as these clearly depict an antithesis to the term city.

“City-landscape and landscape-city are two different perspectives of urban landscape, depending on whether it is viewed according to the disappearance of the traditional city shape or to the increasing urbanisation of the traditional cultivated landscapes” 7.

These new urban phenomena also require a new, spatial approach. Therefore, the cluster of research aims at exploring and developing methods of research by design within a refounded architectural urbanism.

From this starting point, three basic themes serve as a basis for research:

- **Context** deals with the sequential connectivity of specified spaces
- **Capacity** defines the ability of specific spaces to host different programs based on their inner strength
- **Concept** defines the methodological field as a prerequisite to strategic action

**Interdisciplinarity as a method**

In order to create a holistic and forward-looking approach to the city and settlement development of Nyanza, it has been a matter of concern to work on this project in an interdisciplinary team of experts from Germany and Rwanda. The current phase of work lays emphasis on the interacting effects of existing settlement structure, sustainable concepts of infrastructure for the supply of water and energy (based on renewable energies) and which new patterns of urbanisation will develop from these. The project is carried out in cooperation of the “Chair for rural Urbanism and Territorial Architecture” and the “Chair for Climatic Design and Building Services” of Technische Universität München (TUM), including experts from the Kigali Institute of Science and Technology (KIST).

Since settlement structure and farming areas cannot be clearly differentiated as structural spatial unities, but together build the character of a man-made cultural landscape, the cooperation of landscape architects and ecologists is essential. Also, it is very important to include the department “Land tenure and land management” in order to implement new spatial models. Another interdisciplinary project including these disciplines is in application at the moment.

The project “urban and settlement planning in Nyanza” is the first applied research project in cooperation of the department of architecture of TUM and KIST, that is integrated in research as well as in science. Since January 2009, a department for architecture and urbanism has been set up to submit the academic education of local experts in the long run.

**Historic review**

The search for the potential in blending urban and rural elements also was a central theme in the development history of European cities. The garden city concept according to Ebenezer Howard and approaches of self-sufficiency and decentralisation as promoted by Leberecht Migge in his call “Everyman a self-supporter,” were the consequence of urban crises caused by overpopulation, poverty and bad housing conditions during the industrialisation phase and in post-war times. In contrast to an urbanisation of the countryside, the starting point for these visions was a deconcentration and disintegration of the cities. 8 9

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8. The garden city according to Ebenezer Howard was planned as a regional net-work of small towns with a central town and a group of smaller towns; each settlement unit was surrounded by farmland and thus self-sufficient and organised as a cooperative with respect to land law. See Ebenezer HOWARD: Garden Cities of Tomorrow (London 1902)

9. Leberecht Migge demanded that the population should no longer live in the cities under bad living conditions with his call “Everyman a self-supporter” after World War I. He regarded the decentralised reorganisation of cities as a social chance to design “productive parks.”
In the years 1929 to 1958, Frank Lloyd Wright developed one of the largest utopias for a disperse, regional settlement network with “Broadacre City.” An urbanised agricultural landscape without a centre, where every household owns one acre of land to farm next to industrial zones, shopping centres, and schools. Agricultural self-supply was intended to supplement people’s wages in industry. Decentralisation, land for everyone, mobility and individual freedom were the main ideas of this new type of city. New communication technologies and means of transportation were to ensure that everything is linked. The garden city concept and the dream of living in the country can be found around the globe today in a reinterpreted way in the single-family house structures of many suburban settlements. These <intermediate cities> where settlements and infrastructures coexist only bear little quality-oriented reference to the countryside and require an enormous amount of resources. The original concepts of self-supply and the introduction of agrarian use in spatial planning, however, are important instruments that are gaining increasing importance today in planning, particularly in structurally weak regions.

Even if the urbanisation in developing countries proceeds totally different to europe in the 19th century Wright’s utopia of a decentralised settlement network and the idea of independent self-supply can offer an impulse for further settlement development in Rwanda.

**Current research project “urban and settlement planning Nyanza – Rwanda”**

![District Nyanza – dispersed settlement structure](image)

**REGION characteristics and development potentials**

The large-scale investigation area of the research project is the district of Nyanza, that is exemplary for the central plateau region and lies approx. 70 km south of the capital Kigali. Due to an administrative reform Nyanza has been the capital of the new South Province since 2006. Therefore the municipality is faced with numerous tasks in urban planning because of its grown importance and the thus required new space for administration, commerce, and housing. Nyanza used to be the King’s residence. An art and history museum is now situated there, representing a tourist attraction whose potential could be increased by new public buildings and qualitative infrastructure and thus rise the identity formation of the town. The landscape around Nyanza is defined

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See Leberecht MIGGE: Das grüne Manifest (Berlin 1919)
10 Frank Lloyd WRIGHT: Usonien (Berlin 1950)
11 Thomas SIEVERTS: Zwischenstadt. Zwischen Ort und Welt, Raum und Zeit, Stadt und Land (Braunschweig 1997)
12 Philipp OSWALT: Schrumpfende Städte. Band 2, Handlungskonzepte (Bonn 2005)
by rolling hills and wide, plateau-like high-altitude areas. The hilltops are populated while the marshy and highly fertile valley floors usually remain free of buildings and are cultivated. A large part of the population lives on subsistence farming, therefore dispersed settlements and strongly fragmented agricultural areas are characteristic for the cultural landscape in this region. In addition, subsistence farming and the small-scale cultivation of land is deeply rooted in the country’s culture, and the topography makes large-scale, industrially characterised agriculture difficult. An important issue is to find out how agriculture and the settlement structure should be designed and organised in the future to satisfy most of the food requirement for the long term and to operate resource-conserving with regard to landscape, ecosystems and objects of cultural value at the same time. Topics such as ecological farming, organic food, finishing, and direct marketing are not only gaining importance worldwide, but contribute to strengthening the regional economy and to creating local added value. The existing settlement and landscape structure is examined as potential in this research study.

VERNACULAR PRINCIPLES settlement patterns & house typologies & materials
In accordance with the philosophy of our departement, firstly the traditional house and settlement typologies were examined. House, farmyard and plot form the basic unit for various settlement models whose structures range from the prevalent dispersed settlements, one-street villages and villages built around a common to agglomerations with commercial and industrial use. The market square, around which the commercial and residential buildings are positioned, represents the village centre. In contrast to the traditional structures, current developments in the field of concentrated settlement development (>imidigudu<) show that the sensitive system of ecological aspects, the differentiated transition from public areas to private areas as well as the appreciation of the own domestic culture are in danger of being lost.
Anonymous construction in Rwanda has adjusted to the local conditions, particularly the climate, and the locally provided resources over the past centuries. Clay construction already represents a large part of housing construction, particularly among the poor population. The houses are either constructed as solid structures with air-dried clay bricks or as frame structures of wood or bamboo with a clay infill. With respect to the climate, the material is perfectly suited for this climate zone due to its storage capacity. Clay construction also is an example for an existing local circulation model, since material generation, processing and recycling can be performed on site, the material is cheap, easy to process and its production requires little energy. Thus, it also contributes to lowering the primary energy demand. Unfortunately, the material is only little appreciated, since clay is only used by the poor population.
It is one aim of the project to improve the image of the construction material through architectural projects in the sector of public and private buildings and to develop strategies for low cost housing built in clay. In a similar way, local building material production and the use of low-cost materials with labour-intensive production can strengthen the local economy and contribute to generating income.

**INFRASTRUCTURAL CONCEPTS** for water and energy as spatial elements

In principle, there is no shortage of water in Rwanda, as the region is rich in wellsprings and rainfall. However, access to clean drinking water must be improved as well as a plan for waste water disposal will be indispensable to protect water reservoirs in the future.

Rwanda’s average energy consumption per capita rates among the lowest in the world. However, the few forests that are still left have been reduced extremely as wood is the main source of energy for cooking. Besides, fetching drinking water and gathering firewood can be extremely time-consuming.

Providing drinking water and sustainable energy for cooking, lighting and heating can reduce the drain on household income, while freeing up time for education and income-generating activities. Therefore, it will be examined which water- and energy-generating technologies are adequate and practicable regarding the country’s climate and its social and cultural conditions and which technologies will protect existing local circuits.

Due to the dispersed urban structure in Rwanda and especially in the considered region Nyanza, central concepts for the infrastructure can be realized merely partially. The local energy and water supplier will provide a central supply only in profitable areas. This applies to a central fresh water supply as well as to a central power supply. Beyond these economically operated service strategies, we question particularly conventional, centrally organized infrastructure provision for dispersed settlement areas due to the connected disproportionately long supply routes.

On the other hand the lack of capital is another barrier for a future power and water supply. Thus feasible projects may only require a minimum of initial investment. Therefore particularly local solutions for energy supply are merely realizable. Gaining solar power is not fundable and potential for mini hydro systems exists only in places. Based on the low biogas output of the common systems, gaining power by biogas is not possible.

Therefore, at the first step the focus is put on the improvement of life quality regarding water supply and wastewater disposal. Latter is partially attended by energy supply by biogas systems (gas production for cooking and lighting) but without gaining power by gas. Also new technologies for electric devices without connection for power supply have already been invented (laptop with handwheel provided by the organization “one laptop per child”).

Social pressure causes new urban structure but also redensification in consisting settlements. In developing new urban structures, architectural and urban boundary conditions must go along with possible infrastructural measures. That means that contingent supply concepts of arising settlements are a decisive element for the future appearance and dimension of the settlement.
Due to the implementation of centrally organized grids for electricity, gas and water, areas of higher agglomeration like cities or towns benefit and rural areas miss out. This difference in infrastructural supply leads to a migration of people from the rural to the urban areas. This migration results in densification of the cities and development of informal settlements along urban fringes. As the main productivity and income in Africa in general is generated through agriculture and as most of the people don’t get an education to work in other fields the position of the farmer has to be strengthened and development of energy supply systems should also start in the rural areas. Decentral systems also allow an urbanisation of existing settlement structures, which will – depending on the chosen service system - cause new patterns of urbanization. Intelligent synergies of high-tech and low-tech have to be aspired in order to achieve economic independence and self-reliance and in order to create new jobs. Recently the concept of leapfrogging is being used in the context of sustainable development for developing countries as a theory of development which may accelerate development by skipping inferior, less efficient, more expensive or more polluting technologies and industries and move directly to more advanced ones. It is proposed that through leapfrogging developing countries can avoid environmentally harmful stages of development and do not need to follow the polluting development trajectory of industrialized countries. Thus, the “ecological footprint” of these countries can remain small in the future and give an example for industrial nations.

NYANZA future strategies and spatial concepts
In the district of Nyanza we did focus on three exemplified areas containing a sphere of activity. On the one hand the inner-city condition was examined (towncentre Nyanza), which largely is equipped with a central water and energy supply. On the other hand there is an rural engraved area without any connection to an infrastructure (Rwabicuma).
In Rwanda there currently still exist spots that are only accessible by foot and accordingly don’t have access to a water or energy supply. As a third sphere of activity concepts of amalgamation of both presented types of settlement have been reviewed.
In the considered case a connection to the traffic infrastructure is almost optimal, however energy and water supply is still missing (Mukingo).

Sphere of activity ‘urban’ (towncentre Nyanza):
The township of Nyanza should develop to an urban centre of an important, identity creating, secondary city in the south of the country. Currently dense areas can be found around the market area and extend to the neighbouring hills. A linear densification also occurs along the regional highway from North to South. The hills are usually populated and the hilltops are mostly occupied by greater building complexes, which appear as “landmarks” while even here the valleys remain free of buildings. Also rural living areas with low density and a wide-spread settlement structure do exist near the centre.

There is a certain concentration of different functions in the town centre, such as the regional market, trading shops, hospital, secondary schools, district administration and the museums. Functions of daily needs and local administration buildings have a decentralized distribution. Because of good accessibility of these public services the centre is still pedestrian orientated.

“The landscape structure represents a mosaic of differentiated, multifunctional use, adapted to topographic and site differences. Highly diverse parts of the landscape – with respect to species diversity as well as to structural and ecosystem diversity – can regularly be found on the slopes of the hills, especially on the lower slopes. More extended areas of forests or woodland are oftenly situated on the hilltops on plateaus.”

In general, there is a central infrastructure net in the centre, that already provides supply for water and energy for the more dense areas. Areas with low density do use public water kiosks, wells and sources for water supply.

The further settlement development will be effected by the following principles:
The topography will be the backbone for an distinctive spatial pattern of areas with a dense building structure and public spaces on the hilltops, residential areas with medium density on the slopes and more rurally influenced areas with a connection of living and agriculture on the lower slopes. The concept includes a specification of areas for administration, commerce, retail, industry as well as residential use and mixed used areas. The special character that the hilltops are usually occupied by public buildings will be continued and this identity will be strengthened by recommendations for positioning of further public buildings. Areas that have difficult topography such as precipices and regions that do not offer a good infrastructure will not have a high density of settlement in the future. For the identity of Nyanza and for the generation of job opportunities the museums play an important role. Further functions and buildings will promote a sustainable development for tourism in connection with the planned Olympic City.

Landscape protection zones will be defined. Wetlands in valleys – with respect to their natural state – are able to prevent erosions and floodings. They are important areas for assuring water quality. Wetlands are specific habitats for native species of flora and fauna. Hence, these wetlands should be used for a highly diverse agricultural production in some areas, and they should be restored in other areas in order to improve their very important ecosystem services and functions (carbon sinks). Ecological buffer zones in the riparian zone along the streams and brooks will be defined and realized. New zones of reforestation will be defined, and the rules for moderate, “sustainable” use of wood (timber) will be developed.

Especially with respect to these highly diverse and heterogeneous hills and slopes it should be analysed, how further settlement growth can be steered. The visual orientation between settlement and landscape will be kept by spatial interruptions within the living areas – especially on the anticlines – which provide visual axes towards the landscape.

Furthermore a concept for wastewater disposal has been developed.

Regarding that the central energy and water supply is acceptable and only has to be extended in fringe areas, the focus has to be on the wastewater treatment. The focus here was put on the minimization of the pump exertion. The proposed spot for
the waste water disposal plant was chosen by several determining factors. On the
one hand the possible layout of the line already constricted the choice of sites. On
the other hand a sufficient availability of expanse with an adequate topography and
a possible water inlet after the treatment must be found. Moreover, the area must
not be settled too densely, still the location should lay close to the township. For the
realization of the clarification plant a toolbox was developed to explicate possible
types of clarification plants plus their pros and cons. The community itself must select
the type according to its financial possibilities and technical skills.

Based on the extended, central infrastructure net new living zones with high and
medium density can be connected and existing settlements will be upgraded and
densified.

Sphere of activity 'rural' (Rwabicuma):
The second focused area in the sector of Rwabicuma is a rural area situated in the west of Nyanza centre. The population density with 280 persons per km² (see Nyanza District Development Plan 2007) is comparatively low, the settlement structure has a wide-spread character with many single farmsteads, smaller house groups (hamlets with 4-5 houses) and three denser villages. The area is poor in agricultural production and neither has access to traffic infrastructure nor access to central water and energy supply.

The administrative structure, which splits the district into 10 sectors, again sub-divided into 5-6 cells, supports a decentral distribution of daily needs. Near to the appropriate administrative buildings on cell or sector level, there are — and also shall be in the future - different public functions, like smaller markets, health centres, primary schools, kinder-gardens which form a kind of sub-centre. This principle with short accessibilities will avoid unnecessary traffic. It is an urbanistic chance to form a spatial-architectural concept for these sub-centres.

The handling of landscape and the definition of protected areas is carried out under similar aspects according to the other described area.

Decentral models (with local networks) for water and energy supply will be provided in the rural areas which are based on commonly used rainwater collection in cisterns and biogas. For the placing of decentral water spots like wells and water kiosks minimal demands on accessibility are determined. The distance to the next water access should not exceed 200 metres in urban areas and 500 metres in rural areas. Central infrastructures will not be provided in the next years or decades. Due to lacking demand and accessibility the water- and energy suppliers are not interested in opening up those areas. Water remittance takes – depending on the area – up to four hours, because of the distance to the next all-season spring and from the holding time at the spring itself.

Suggestions for action to improve the local water supply have been compiled. This contains simple and pictorial guidance to build a cistern, to handle aquifer systems from roofs to the shared cistern i.e. in the center of a settlement cluster. Great importance was paid to the local accessibility of cheap available materials such as bamboo and quarry stone.

Thus the expenditure of time to supply water can be slashed. Furthermore sufficient water quality can be achieved by adequate filter measures and by boiling off the water.

(fig. 7) Rainwater utilization with bamboo water pipes and gutter

Rainwater utilization with bamboo water pipes and gutter
Furthermore settlement clusters are defined which qualify for biogas production (from dejection and biomass). Using the produced biogas for cooking and lighting means combustible wood for cooking can at least partially be substituted. This is important as to the protection of resources in Rwanda. Remainder materials of the gasification can be used for manuring the fields. (blau markierter Text ist eigentlich Mukingo zugeordnet, passt aber hier besser)

The existing settlement structure demands different system sizes of biogas production, thus three different spatial densification strategies are defined.

The existing villages will be densified and a biogas plant on community level will be built, using the waste and dejection of 30 households as well as dung of a cooperative cow barn.

Disperse rural areas with a certain density will be densified in a way that 5-6 households share one digester. In rural areas with unfavourable settlement requirements no further densification will take place, here each household is promoted to get one biogas plant, that will be fed by the waste of 5 persons in addition with plant waste or dung of one cow. An agricultural parcel of at least 1,2 ha is needed to get the required plant waste. In consideration of the expected population growth the more realistic alternative for self-sufficient single-farms is to feed the plant with dung in combination with the “one cow per family” programme.

Sphere of activity ‘immidugudu’ (new settlement in Mukingo):
The third focused area in Mukingo is situated in the north of the centre near the regional highway from Kigali to Butare and formulates the entrance area to Nyanza district as well as the sub centre on sector level. Close to the main road into the area Mukingo two street villages with different mixed used functions, the sector office, the primary school and a small market square are located and formulate a small settlement concentration. A second settlement of rather high density that has development potential, is located north west of the clinic Gatagara, which is also part of the focused area. There does exist a central infrastructure net for energy and in parts for water along the highway and for provision of the clinic. Nonetheless, a bigger part of the households is not connected. Further densification and upgrading of the existing settlement concentration as well as the construction of a new immidugudu with 100 units should on the one hand formulate a vivid sub centre and an adequate entrance area to Nyanza district. Thereby, on the other hand, the extension of the

![fig.8](different densification clusters with biogas)
existing infrastructure net could be profitable in near future. The individual project planning for this new immidugudu shows the spatial concept for a new settlement cluster, that could be connected to the central system of energy and drinking water. The new cluster is composed of several courtyard units, which are developed for 10 families each. In spite of a central water supply - the unit allows an effective rainwater collection due to a common roof, which could be used for domestic use or irrigation. As soon as an adequate density is reached, a central power supply is also aspired.

Moreover, this new courtyard-typology also operates as self-sufficient unit in rural areas. Biogas again could be procured by a common digester. Energy production also might be possible via photovoltaic elements, in case it is convertible from the financial aspect.
Those spheres of activities are transferable to other settlements in the region for the most part. Access to drinking water obtains priority. Due to an improved accessibility of water there is a gain of time which allows other projects to be developed.

_Future prospects_

A new appearance for the urban cultural landscape – landscape-city –, based on the endogenous values and the character of the traditional dispersed settlement, can give Rwanda the future potential to generate sustainable strategies for rural regions as well as a future economic basis for the population. This new urbanisation model could be innovative regarding the conservation of resources and is able to cope with the forecast increase in population also expected for rural areas. In this context, architecture and building culture can contribute particularly to strengthening regional identity and are the basis for development.

The situation in Europe is totally different to this development. Rural regions are not characterized by growth, but rather by shrinkage. Settlement structures are similar, in particular urban sprawl/settlements with scattered buildings. Population decrease will lead to a thinning of existing settlement patterns as well as fossil fuels become rare, thus decentral infrastructural models on the base of renewable energies will become more relevant. The spatial connection between settlement density and infrastructural supply will require new approaches.