

## WORLD OF SPREADING CITIES SEEN FROM SPACE – AN EXAMPLE CHAPTER OF THE SEOS PROJECT

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### **ABSTRACT**

Cities are increasing in size and number all over the planet especially in developing countries. The growth of mega cities and settlements can be visualised and analysed with the help of modern remote sensing methods and time series of various satellite systems. Bringing this global and current topic vividly into schools is the aim of one module chapter in the European remote sensing project called “Science Education through Earth Observation for High Schools” (SEOS).

In this project are altogether 15 interactive learning modules in five areas being developed by eleven European partners. The Department of Geography at the University of Education Heidelberg is developing two modules, one about the basic methodology of remote sensing and one module about using satellite images to monitor land use changes when the topic of urbanisation processes is presented.

The aim of the second module is to build awareness of the consequences of land cover, land use change, and land consumption in example areas with the help of satellite images in different landscape zones. An understanding for the local and global causes of land cover and land use change should be created through using satellite images and interactive learning modules. The focus of the presentation is the analysis of global urbanisation processes and the increase of million- and mega cities in five case study cities. The users should be able to evaluate the ecological and economical consequences of land cover and land use changes and should analyse the future of urban areas after having worked with the module.

### **INTRODUCTION**

Have you seen the satellite derived image “World at night”? There, the city lights can be seen as yellow points and lines like a spider’s web spanning over large parts of a dark blue earth. Europe, North America (especially the US), and large parts of Asia are nearly completely lit, whereas most of Africa lies in darkness. But what can we see in this image? The spreading cities and agglomerations? Yes, but can we say: the lighter the area, the more people are living there? No, we can’t.

For the topic of urbanisation satellite images possess a great didactical and activating potential and present a good way to analyse a global issue on different local scales. But we also need more information, images, comparisons, and material to grasp the whole process.

### **URBANISATION PROCESSES – WORLDWIDE AND “IN SCHOOLS”**

At the end of the 19th century less than 3% of the world's population was living in urban areas. But starting with the Industrial Revolution, the urbanisation process has increased and become a more and more global one. In 1990, 73% of the population in industrialised countries were living in cities, only 37% of the population in developing countries. Over the last 50 years, the most rapid growth has taken place, which transformed a world in which most people lived in rural areas into a predominantly urban one (i, ii, iii).

A new phenomenon which can also be seen in this century, is the increase of million- and mega cities. Today, mega cities are home to nearly 10% of the global urban population, whereas two

thirds of today's mega cities are located in developing countries, most of them in East and South Asia (ii). Reasons for the urban population growth today are in-migration, natural population increase and administrative reclassification of urban areas. Most urban growth results from a natural increase rather than migration, whereas migration is a complex human response to changing local circumstances within a global economic system, depending on so called push- and pull-factors (iv, v).

Urbanisation and associated processes are not only huge regarding figures and numbers, but are also huge regarding accompanying problems and challenges, as Kraas stated "Cities will be the laboratories of the future" (vi). Large cities, or mega cities are especially vulnerable in crises and disasters, like, for example, earthquakes, storms, and floods. The increasing urbanisation in developing countries is accompanied by a growing marginalisation of broad classes of population. They are living in marginal neighbourhoods (like slums, favelas, squatter settlements, etc.) which show the significant deficits in technical and social infrastructure (vii, viii).

While the cities in the "global South" are struggling with housing shortages, marginalisation of most inhabitants, energy shortages, and so on, the Western world is confronted with spreading urban areas, extensive suburbanisation processes, gated communities and the segregation of neighbourhoods.

As we can see, urbanisation is complex, inevitable, and one of the most pressing global challenges of our time. But it is also an important topic in the German secondary education curricula. The federal state of Baden-Württemberg includes the issue of urbanisation in the curricula for the upper secondary school in the highest level (a-level). In the fourth thematic complex of sustainable development, "The students should be able to analyse a global thematic complex like urbanisation concerning scale, causes, and consequences and evaluate action approaches of problem solving regarding sustainability" (ix, translated).

## **REMOTE SENSING – FASCINATING METHOD FOR SCHOOLS**

This current and fundamental topic of increased worldwide urbanisation is mostly presented in school books with graphs, tables and pictures of booming cities. A new and fascinating view on the topic and the spreading cities can be included by new and modern remote sensing methods. Satellite images and satellite derived data can be used to visualise and evaluate the situation of a city at its full extent. Also, changes over time, spreading city areas, and inner-urban changes can be demonstratively illustrated by high, medium, and sometimes low spatial resolution satellite imagery.

Moreover, satellite images are spreading more and more frequently into the everyday life of people and students through television forecasts, GPS navigation, via Google Earth, etc. The great potential of these images is very well known and has been used in science over the last 30 years. But, although satellite images are used ubiquitously for scientific, commercial and everyday life purposes, they are only so far to an extent included in teaching and in school curricula of various countries (x).

Satellite images expand the narrow earthly view and enhance the visibility of large spatial structures and environmental changes like the sealing of former agricultural areas due to city expansions etc. (xi, xii).

An international comparative study about the use of satellite images in schools found out, that the majority of students are interested in working with satellite images but did not do so regularly (xiii, xiv). In the selected countries Germany (53%), Poland (64%), and England (81%) the majority of students already used remote sensing imagery in school, less the 50% did that in the US (45%), South Korea (37%), and Turkey (36%). But the interest in working with satellite images is altogether higher (than the number for usage). In the selected countries the interest is above 70% each time. The students were asked if working with satellite images was interesting and could answer with exactly/ almost true or fairly/ not at all true (see figure 1, xv).

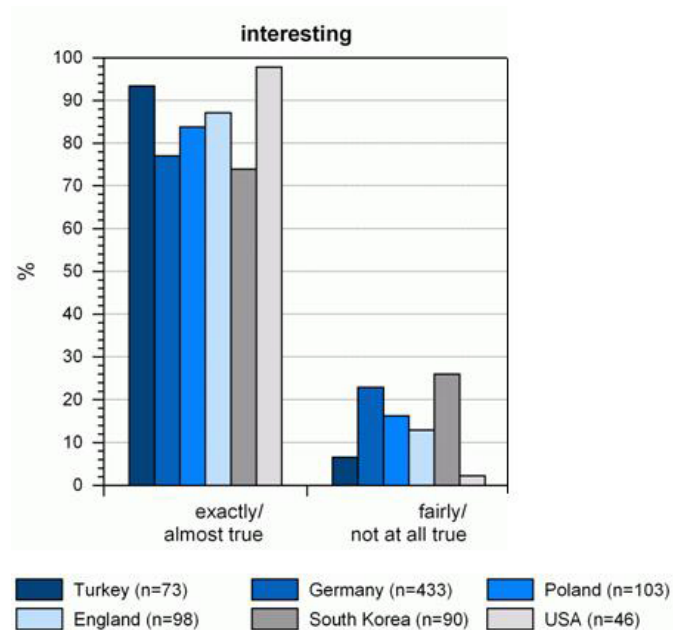


Figure 1: To work with satellite images in school was ... (xv)

This interest can be used to integrate satellite images more frequently into school topics as it is done with the SEOS project and the developed learning modules, for example with urbanisation processes.

### SEOS – INTERACTIVE MODULES

Within the European funded project ‘Science Education through Earth Observation for High Schools’ (Activity Code AERO-2005-2.3.2.1e) online based learning modules and teacher manuals are developed for the application of remote sensing in different subjects. The project aims at integrating earth observation by means of remote sensing in science education in high schools as “it sharpens the sensitivity to the natural environment and thus stimulates the willingness to learn of its relevance in everyday life conditions”(xvi).

A total of 15 interactive modules have been developed in five areas (Remote Sensing for Earth Observation, Geography & Biology, Physics and Monitoring Technology, Environmental Sciences, Hazards & Environmental Management and Mathematics, Statistics & Modelling) which can be used in different school subjects like biology, geography, and physics, as well as be used interdisciplinarily. All modules are tested, evaluated and improved with the aid of several partner high schools throughout Europe. In the end, the modules should be available in different European languages, starting with English, German and French. A preview of the modules can be found at: [www.seos-project.eu/modules](http://www.seos-project.eu/modules).

The Department of Physical Geography and its Didactics at the University of Education Heidelberg is responsible for the overall didactical concept of the learning modules, a methodological introduction to remote sensing and for a module about land use, land use change, and land consumption.

The didactical concept, based on current research results (xvii, xviii, xix, xx), shapes the modules in the following way: Besides didactically prepared information and relevant and appealing images the “online pages” consist of different thematic units, additional materials, exercises, tasks, and some educational games, for use in school or as deepening and learning assessment for homework or exam preparation. With the help of the educational games, the students can test their knowledge about satellite images and their applications in a hands-on, activity-based and problem-oriented way. Besides the information for students, additional links, literature lists, and commentaries are given for teachers as well as worksheets and their solutions.

The aim of the module "Land Use and Land Use Change" in the area of "Geography and Biology" is to build awareness for the problems of land cover and land use change in example areas with the help of satellite images in different landscape zones. Firstly, different global land use changes are presented in their cause-and-effect-chain. On the basis of some case studies of land use change, like urbanisation, syndromes of global change as well as mass tourism; focusing on the island of Tenerife, the students are introduced in the topic in a detailed and problem-oriented way. Through interactive elements like switch-images, drop-down boxes, and learning games, the students can find his/her way through the online material at his/her own pace and style – finding the relevant information to answer given tasks or accompanying worksheets. This can be done in different working modes, alone in front of the PC, in small student groups or together in class with teacher guidance, as homework, or exam preparation.

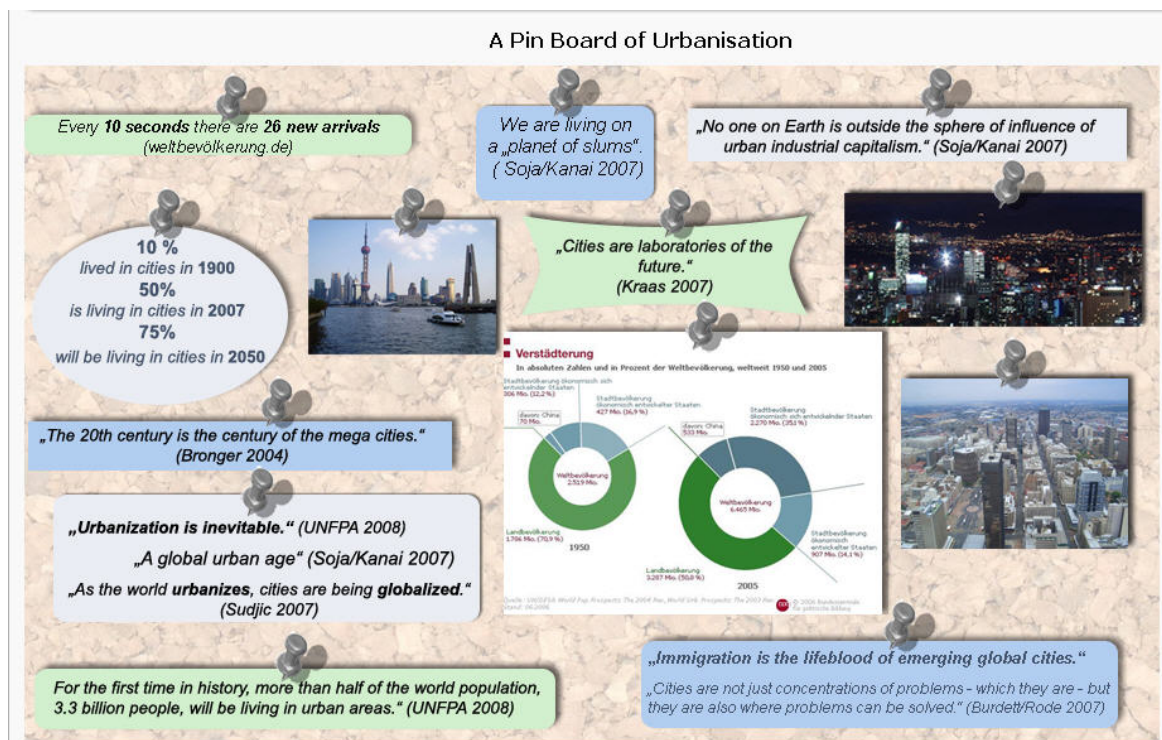


Figure 2: First page of the chapter about urbanisation – a pin board

Urbanisation processes are one of the most important land use and land cover changes of our time. The module integrates this overall phenomenon and the use of satellite images in the interactive learning unit (see the starting page in figure 2). Within this unit, an overview over the worldwide process of urbanisation and the increasing number of mega cities, especially in the developing world, is given. Then, different urbanisation processes on the continents are presented in an interactive satellite image. As case studies, the five mega cities Los Angeles, Mexico City, London, Johannesburg, and Mumbai are exemplarily analysed in their local situation (see collage in figure 3). For the problem-oriented way of learning there are special topics about each case study city about which the students should come to discuss. For Los Angeles, the model of urban realms, giant urban agglomeration is picked out as the central issue accompanied by various satellite images in different perspectives. In the capital of Mexico, Mexico City the location of the city and the subsequent smog issue is presented with a short film, different images, graphs, and illustrations about the air conditions and haze on the high plain. The world city of London wants to become a prototype green city and has started several programs such as "The London Plan" and "The Green Home Program", the focus of this case study. The city of Johannesburg is presented with its historical development and current segregated living communities – townships and gated communities with a mix of different media like satellite image, map, and a historical photograph. For the mega city of Mumbai the focus lies on high population densities in some parts of the city, and, es-

pecially in the largest slum in Asia, Dharavi. Problems addressed here are the living conditions, economical factors, types of marginal settlements, and a new governmental plan for Dharavi.

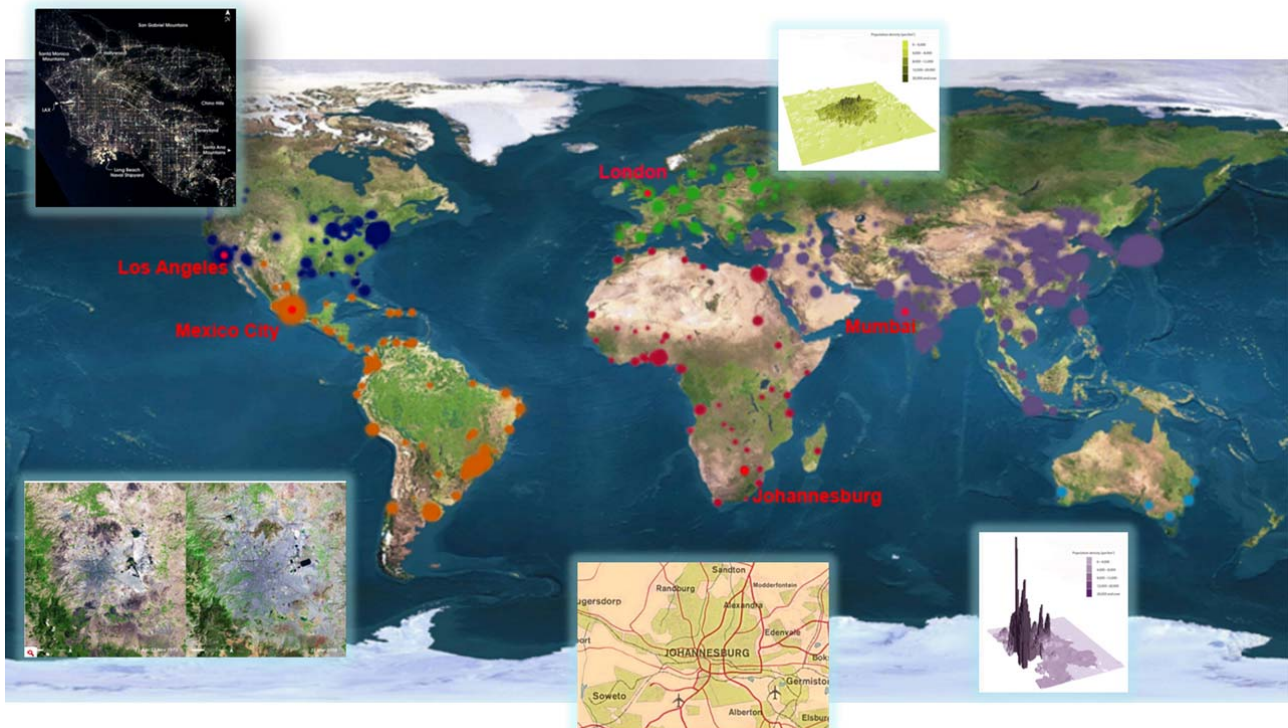


Figure 3: Collage of the urbanisation world map with graphs to the five case study cities

With the help of satellite images from different dates, a comparison of urban situations in the past and today is possible. To complete this section, causes and consequences of urbanisation processes are highlighted as well as future developments.

## CONCLUSIONS

Urbanisation processes are one of the most important causes for land use change and land consumption. Satellite images are one of the best methods to monitor such large and spreading changes globally. To encompass both issues into school in an interactive method is one step towards getting students interested and involved in the topics and its sustainable future prospects.

## ACKNOWLEDGEMENTS

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