International Journal of Environmental Trends (IJENT)
http://dergipark.gov.tr/ijent

International Journal of Environmental Trends (IJENT)
2019: 3(1),17-30
ISSN: 2602-4160
Turkish JournalPark ACADEMIC

Research Article

Geodesign for Urban Planning : A Case Study from Harran University's Campus Master Plan

F. B. Ernst[1], S. Erdoğan[1], M. Yılmaz[1], M. Ulukavak[1], H. İ. Şenol[1], A. Memduhoğlu[1] and M. A. Çullu[2]

[1] Harran University, Department of Geomatics Engineering, Şanlıurfa, Turkey
[2] Harran University, Department of Soil Science and Plant Nutrition, Şanlıurfa, Turkey

Abstract

Since 10 years Geodesign has been applied in regional and urban planning throughout the world. The Department of Geomatics, Harran University (HU) has been charged with the design of a new master plan using Geodesign technology. "Geodesign Hub", an online software for collaborative Geodesign, has been selected for this project. Evaluation maps created based on the judgment of experts in the respective field of specialization. ESRI's CityEngine used for the creation of realistic models that can easily be understood by the higher management. This is being realized by conducting several workshops with the participation of the higher management of HU. The most striking feature of Geodesign Hub was that the participants could see the impacts of the individual projects that made up their designs immediately.

Received
05 November 2018

Accepted
19 March 2019

Keywords
Geodesign
Urban Planning
GIS

International Journal of Environmental Trends, *3* (1), 17-30. DOI: not now possible

[1] Corresponding Author
Email: f.b.ernst@harran.edu.tr

INTRODUCTION

Master planning in Turkey

Nowadays, the concept of Master Plan is thought to be the design of many elements, including the different parts of a region and the transportation corridors connecting them, guided by a certain mission and vision. In fact, this is in full compliance with the definition of the Master Plan in Construction Law No. 3194 [1]. First, in these plans it is necessary to see the general land use of the parts of the territory on maps (using cadastral maps as background if available) from the regional development or environmental plan. Then, in a broad framework of major regional units the plan should consider to remove disparities in future population densities, related building densities when necessary, and the development directions and sizes and principles of the various settlement areas. At the last stage, it is necessary to show aspects like solutions for transportation problems within the region and in relation to neighboring regions and to make arrangements based on the preparation of applied regional development plans and to present the plan in full detail in the context of a detailed report.

This concept of master plan can easily be applied to universities. Universities, which address at least a major part of the educational need of a region, are a miniaturized model of a city consisting of social facilities, laboratories and classrooms having their own administration and a transportation network ranging from sidewalks to roads and providing accommodation and food in the form of restaurants, canteens and dormitories. When planning the above-mentioned components of a university campus, not only the number of buildings or roads, but also the number of students, academicians and administrative staff and their families who are expected to study, work and live at the university every year should be considered. In this context, the compounds of universities should be organized and planned in accordance with a specific plan, namely the provisions of a Master Plan.

Master planning in the above-mentioned sense has started at Turkish universities as joint studies between their academic and administrative units. For example, the Master Plan of Atatürk University (AU) Campus was created under the name of Atatürk University Sustainable Campus Master Plan. Following the first master plan prepared in 1955, this new plan consists of 1/5000 scale spatial development and 1/1000 scale implementation plans and their additions as well as a physical 3D model at a scale of 1/1000. With this plan, it is thought that the university will be able to direct all of the spatial changes, transformations and developments that will be experienced in the coming 100-year period [2].

An example of the sustainable campus approach is the changes that Abdullah Gül University (AGU) has planned for its Sumer Campus. The project aims to make the buildings belonging to the Sumerbank Kayseri Cloth Factory and Lodgings established at the beginning of the Republic re-functional. These buildings that have not been used within the campus boundaries until now, have been re-acquired to made them usable for educational purposes [3]. Another research conducted within the scope of the sustainable campus approach is the planned study of comprehensive targets and strategies for the Gebze Technical University (GTI) Campus of Çayırova. In this study, the role of universities in sustainable development was first discussed, and then sustainable campus guidelines and objectives prepared by the United Nations Environment Program (UNEP) and the International Sustainable Campus Networks - Global University Leaders Forum (ISCN-GULF) campus design goals have been formulated [4].

After the historic HU was abandoned about 1500 years ago, the new HU was established in the Province center of Sanliurfa in the year 1992. In 1993, its main campus, Osmanbey located 20 km distant to the city center was created from scratch (Figure 1). With an area of 2870 ha Osmanbey Campus has an enormous development potential. In 2016, a new master plan was created by a private company. As this master plan was designed neglecting the current natural environment and realistic future projection, the Department of Geomatics Engineering of HU applied for the design of a new master plan using Geodesign technology that was approved in early 2017.

Figure 1. Location of Osmanbey Campus

Master planning using Geodesign

According the author's research, the word "Geodesign" has been mentioned for the first time by the German urban planner Klaus R. Kunzman in the article "Geodesign: Chance oder Gefahr?" (Kunzman, K.R., 1993) [5] in 1993. However, its practical usage can be traced back to the earliest beginnings of human culture. The word Geodesign consists of two components: 1) Design, which is almost the same as planning of any kind and 2) Geo, which as a prefix is taken from the Greek word γη or $\gamma\alpha\iota\alpha$ meaning "earth", usually in the sense of "ground or land". That means that in a broader sense any planning reaching beyond the closest surrounding of humans (like for example interior design) could be considered to be Geodesign.

While many researchers have dealt with Geodesign in the 20th century, the work of three of them has to be mentioned in more detail when discussing Geodesign; Ian McHarg, Carl Steinitz, and Jack Dangermond. In 1969, McHarg, landscape architect and lecturer at University of Pennsylvania, USA, wrote the book "Design With Nature" (McHarg, I., 1969) [6], which is often considered to express the principles of Geodesign for the first time. It expresses the value of designing with nature as related to the fields of landscape architecture and regional planning. On the level of methodology, based on the early works of Warren H. Manning in 1923 (Steinitz, C. A, 2012) [7] he introduced the concept of overlaying thematic layers of geographic information to assess the best location for a particular land use. Of course, at that time this overlaying technique was totally non-digital using paper maps. Still, this technique laid the foundation for digital Geographic Information Systems (GIS) by organizing geographically referenced thematic layers of the physical environment and social-economic conditions and by analyzing them for obtaining conclusive results.

In 1995, Carl Steinitz who was working with his colleagues and students over a period of approximately 30 years at the Harvard Graduate School of Design developed a complete framework for doing geodesign as applied to regional landscape studies. This framework originally called Framework for Landscape Planning and later renamed to Framework for Geodesign (Steinitz, C. A, 2012), advocates the use of six models to describe the overall planning (geodesign) process as shown in Figure 2.

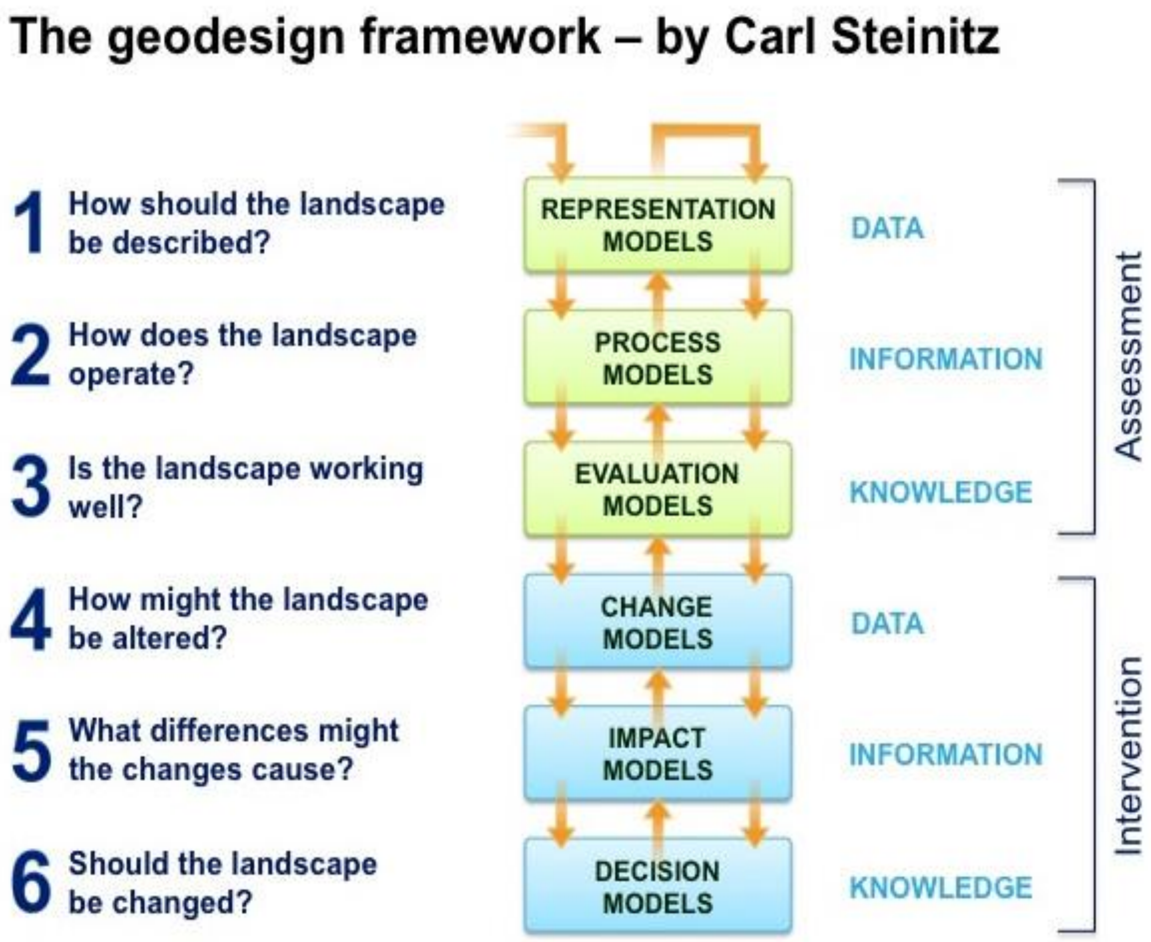

Figure 2. Six models of the Geodesign process

In "Framework for Geodesign" the author delineates the conceptual framework for doing Geodesign, which is considered to be the standard book for both practitioners and academics.

Jack Dangermond, president and founder of Esri, was one of Steinitz's students at Harvard. He was studying landscape architecture but was also keenly interested in the work at the Laboratory for Computer Graphics and Spatial Analysis. After graduating in 1970, he used Harvard's SYMAP, one of the first computer mapping programs to start his company, which is now the world leader in GIS technology. In 2005, it is reported that it was him who made the term popular. This happened during a demonstration of a then newly developed extension for ArcGIS called "ArcSketch", a tool that enables the sketching of land use plans without using complicated GIS tools (Miller, W. R., 2012) [8].

Since 2010, ESRI is holding an international conference on Geodesign in Redlands on a yearly basis. Since 2013, similar conferences on the European level take place.

Every organization, large or small, public or private, does three things: it gets and manages information (data), analyzes or assesses that information with respect to some purpose (analysis), and (based on that information and those assessments) creates or re-creates goods and/or services (design). It is, in fact, the creation or re-creation of goods and/or services that gives most organizations their reason for being. If for this creation GIS is used then actually, we can speak of Geodesign.

In his book "Geodesign – Case Studies in Regional and Urban Planning" McElwaney (McElwaney, 2012) [9] lists seven key characteristics of Geodesign. However, during the ongoing discussions of our project the following three characteristics have been determined as the most important ones:

1. Goedesign provides a fast feedback on your changes to a plan making the impacts of it immediately visible.

2. Geodesign supports a participatory approach giving all stakeholders a voice for the planning of their future.
3. Geodesign uses an intuitive GUI that allows the active participation of a multidisciplinary project team and decision-makers at the same time.

There is nothing like "the" Geodesign methodology. This has to be found out for each project separately. After testing of different systems, we decided to go with "Geodesign Hub" found by Ballal (Nyerges, 2016) [10]. Geodesign Hub is an online software for collaborative geodesign. It enables teams to create and share concepts, to design collaboratively, and to receive change-assessments instantly – all in a highly synergetic, efficient and easy to use environment.

MATERIAL AND METHOD

Work on evaluation models

For the Osmanbey Campus 10 systems, for which an intervention in means of new developments or any other major change in the near or middle term are expected, have been selected. A list of these system with a short description and its criteria is given below (Table 1). Criteria are those parameters that are used to evaluate whether changes fall in one of the five evaluation classes: feasible, suitable, capable, not appropriate or impossible (here called "existing"). Under criteria the respective GIS layers that have been used as an input are indicated.

Table 1. A list of 10 systems with a short description

System	Description	Criteria
Teaching Facility		distance to water courses, distance to existing facilities, land cover classes
Transportation	Includes highways, major roads, connecting streets and pedestrian walks.	distance from road centerline, land cover classes
Housing	Middle density housing (up to 5 floors) for staff and students	distance to water courses, distance to highway, land cover classes
Villa	Low density housing (1-2 floors) for staff	land cover classes, distance to water courses, distance to highway
Agriculture / Food Production	Suitability for agriculture and food production	land cover classes, soil capability classes, distance to highway
Greenhouses		land cover classes, distance to water courses
Small Food Processing Facilities	SMALL ORGANIC AROMTIC PLANTS AND SUN DRYING	land cover classes, distance to water courses, distance to main road and highway
Forest and Protected Areas		land cover classes, conservation typea
Recreation Areas		land cover classes, distance to water courses, distance to conservation sites
Spa and Related Facilities	Extension to existing hospital	land cover classes, distance to water courses, distance to existing hospital, soil capability classes

Each system is similar to a suitability map. The difference to the standard approach to suitability analysis is that instead of producing one suitability map, ten suitability maps for each system are produced.

Input data describing the data and process models (the first and second model according to the Geodesign framework of Steinitz) have been processed using GIS technology. The underlying data have been produced based on accepted scientific standards (e.g. soil suitability map) and are not further dealt with in this paper.

On the other side, the selection of criteria and its classification into five evaluation classes cannot fallow a clearly defined scientific methodology. They are subjective and depend on the values and priorities of the persons who work on the evaluation. To give one example from the sytem "Greenhouse", one may argue that locations having a slope of more than 20 % are not appropriate. Someone else might consider all land feasible for such kind of development arguing the return of investment for greenhouses is so high that even taking additional measures for ground stabilization will lead to profitability in the long run.

The above said had two consequences for this project: 1) The opinion of different subject matter experts had to be taken into consideration. 2) The evaluation models had to be revised several times. In addition, based on the input of subject matter experts even one system had to be taken out completely and to replaced by one that better suited the needs of Osmanbey Campus.

The final evaluation models were documented in the form of a spreadsheet (Figure 3). Based on this spreadsheet evaluation maps were produced using the underlying input GIS layers of the criteria contained in it (Figure 4). In many cases, the review of the first evaluation maps showed wrong classification results at some campus locations. Usually, these mistakes were a result of wrong logical expression, e.g. using an AND statement instead of an OR statement. Considering the amount of different input layers, their different classes and different logical operators the total amount of possible combination is quite high and consequently, in some cases finding a sound expression took its time.

Teaching Facility				TEACH
System 1			Contact / Expert Name	
Description of Evaluation: Different land use types classified according to suitability for building teaching facilities. Criteria: Land cover, distance to water courses, distance to existing facilities				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, distance to water courses > 20 m, distance to existing facilities < 500 m	land cover class = all other classes, distance to water courses > 20 m, 500 m < distance to existing facilities < 1000 m	land cover class = all other classes, distance to water courses > 20 m, 500 m < distance to existing facilities < 1000 m	land cover class = 'landscaping', 10 m < distance to water courses < 20 m, distance to existing facilities > 1000 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', distance to water courses < 10 m

Transportation				TRANS
System 2			Contact / Expert Name	
Description of Evaluation: Includes highways, major roads, connecting streets and pedestrian walks. The only criteria for suitable areas to build new roads is distance from existing roads. By this, remote areas that have the highest need for new roads are defined as feasable. However it has to be mentioned that in order to connect existing roads all other classes including not appropriate have to be considered for the construction of new roads. Criteria: Distance from road centerline, land cover.				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, distance from road centerline > 200 m	land cover class = all other classes, distance from road centerline > 150 m	land cover class = all other classes, distance from road centerline > 100 m	land cover class = 'landscaping', distance from road centerline > 50 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'road' OR 'canal' OR 'forest' OR 'pond', existing roads,

Housing (middle density, 5 floors)				HOUSE
System 3			Contact / Expert Name	
Description of Evaluation: Geology map is evaluated against durability in case severe earthquake. Criteria: land cover, distance to water courses, slope				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, distance to water courses > 20 m, distance to highway > 200 m	land cover class = all other classes, distance to water courses > 20 m, distance to highway > 200 m	land cover class = all other classes, distance to water courses > 20 m, distance to highway < 200 m	land cover class = 'landscaping', 10 m < distance to water courses < 20 m, distance to highway < 200 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', distance to water courses < 10 m

Villa (low density, 1-2 floors)				VILLA
System 4			Contact / Expert Name	
Description of Evaluation: Criteria: land cover class, distance to water courses, distance to highway				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, distance to water courses > 20 m, distance to highway > 500 m	land cover class = all other classes, distance to water courses > 20 m, distance to highway > 500 m	land cover class = all other classes, distance to water courses > 20 m, 200 m < distance to highway < 500 m	land cover class = 'landscaping', 10 m < distance to water courses < 20 m, distance to highway < 200 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', distance to water courses < 10 m

Agriculture / Food Production				AGRI
System 5			Contact / Expert Name	
Description of Evaluation: Suitability for agriculture and food production has ben determined by evaluating different soil capability classes. Low number means very high capability, high numbers indicate low capability.				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, soil capability class II, distance to highway is > 200 m	land cover class =all other classes, soil capability class III or IV, distance to highway is > 200 m	land cover class = all other classes, soil capability class VI, distance to highway is > 200 m	land cover class = all other classes, soil capability class > higher VI, distance to highway is < 200 m	land cover class = 'roads' OR 'canal' OR 'teaching facilities' OR 'other building' OR 'housing' OR 'hospital' OR 'pond' OR 'garden' OR 'old olive' OR 'pomegranate' OR 'vineyard' OR 'reforestation area' OR 'forest' OR 'wasteland' OR 'landscaping' OR 'new almond' OR 'new olive' OR 'new pistachio'

Greenhouses				GREEN
System 6			Contact / Expert Name	
Description of Evaluation: Criteria: Land cover, distance to water courses, slope SLOPE NOT IMPORTANT				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, distance to water courses > 20 m	land cover class = all other classes, distance to water courses > 20 m	land cover class = all other classes, distance to water courses > 20 m	land cover class = 'landscaping', 10 m < distance to water courses < 20 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', distance to water courses < 10 m

Small Food Processing Facilities				FOOD
System 7			Contact / Expert Name	
Description of Evaluation: Small organic aromatic plants and sun drying facilities. Criteria: Land cover, distance to water courses, distance to main roads and highway				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = all other classes, distance to water courses > 20 m, distance to main road and highway > 1 km	land cover class = all other classes, distance to water courses > 20 m, distance to main road and highway < 1 km	land cover class = all other classes, distance to water courses > 20 m, distance to main road and highway < 750 m	land cover class = 'lanscaping' classes, distance to water courses < 20 m, distance to main road and highway < 500 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', distance to water courses < 10 m

Forest and Protected Areas				FOREST
System 8			Contact / Expert Name	
Description of Evaluation: Forest are only used for protection and recreation purposes, not for economic purposes. Criteria: Land cover class, conservation sites				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = 'field' OR 'steppe', conservation type = none	land cover class = 'new almond' OR 'new olive' OR 'new pistachio' OR 'pomegranate', conservation type = none	land cover class = 'old almond' OR 'old olive' OR 'vineyard', conservation type = none	land cover class = 'garden' OR 'quarry' OR 'reforestation area' OR 'wasteland' OR 'landscaping', conservation type = none	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', conservation type = 'archeologic' OR 'flora' OR 'geologic'

Recreation Areas				RECRE
System 9			Contact / Expert Name	
Description of Evaluation: Criteria: Land cover, distance to water courses, distance to conservation sites				
Feasable	Suitable	Capable	Not Appropriate	Existing
land cover class = 'forest' OR 'landscaping' OR 'pond', distance to water courses < 10 m, distance to conservation sites < 100 m and conservation sites	land cover class = 'step' OR 'reforestation area', 100 m < distance to conservation sites < 200 m	land cover class = all other classes, distance to conservation sites > 200 m	land cover class = 'road', distance to conservation sites > 200 m	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'canal', distance to conservation sites > 200 m

Solar Energy Plant				SOLAR
System 10			Contact / Expert Name	
Description of Evaluation: Criteria: Land cover, distance to water courses, distance to existing hospital				
Feasable	Suitable	Capable	Not Appropriate	Existing
slope = between 3 % - 15 %, Aspect = South, Southeast, Southwest	slope = between 15 % - 25 %, Aspect = South, Southeast, Southwest	slope = between 25 % - 35 %, Aspect = South, Southeast, Southwest	slope = between 0 % - 3 %, Aspect = South, Southeast, Southwest	land cover class = 'hospital' OR 'housing' OR 'other building' OR 'teaching facilities' OR 'roads' OR 'canal' OR 'forest' OR 'pond', slope = higher than 35 %, Aspect = North, Northeast, Northwest , East and West

Figure 3. Final evaluation models

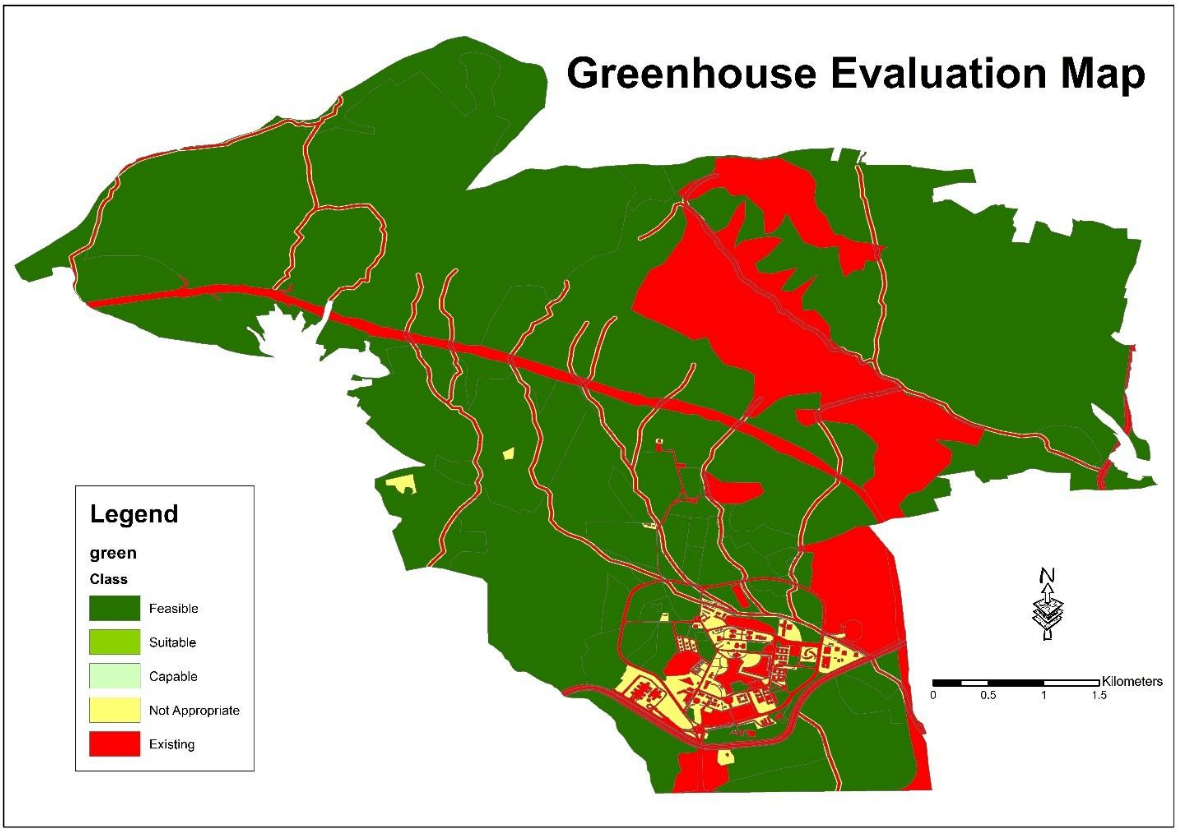

Figure 4. Evaluation map for system "Greenhouses"

Both, the natural environment and the build-up and man-made environment are very dynamic systems. They consist of different subsystems and all of them are linked with each other meaning a change in any of these systems will have an impact on all other systems to a higher or lower degree. Therefore, in addition to these evaluation models "cross system impact models" are created. This creation is based on the existing evaluation models and they subjective evaluation of subject-matter-experts.

Anticipated development of student numbers

The heart of a university is made of its students and professors. Any campus master plan that is not based on a sound needs analysis will just remain a nice map with beautiful symbols without any relevance. In the case of HU, collection of the required data for a need analysis was not as straightforward as anticipated. In order to come up with a meaningful master plan, data concerning the number of students and academic staff and the currently available space for both kind of campus users were required at least on the level of faculties. Because the faculties collect data on their own, standards differed widely and required a process of making them comparable (Figure 5).

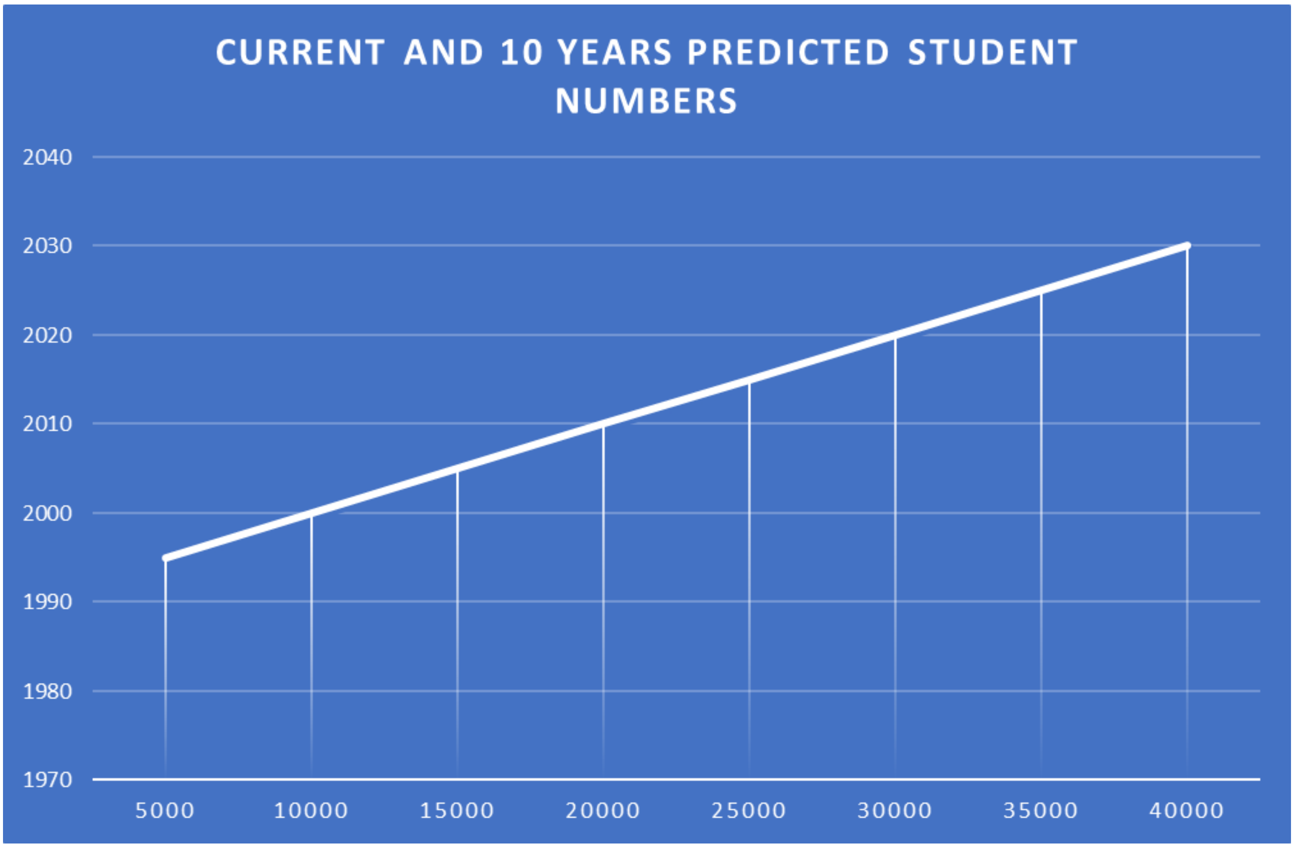

Figure 5. Anticipated students numbers for Faculty of Engineering

Using these data, an evaluation of the current status had to be done. For this, three different standards (American, British and EU) were used. Following these three standards, three different evaluations concerning needs based on the current numbers for students and academic staff were carried out.
Based on these three evaluations, 3 different scenarios for the future development spanning a period of 5 and 10 years were created. As the statistical analysis of historic data revealed non-linear increase of students and academic staff during the last 25 years, the computation of a shorter period of only the last 13 years led to more reasonable results. Still, due to the nature of the highly volatile status of the higher education system our findings might require major corrections in the future.

Change and Impact Models

The next steps according to the Geodesign framework of Steinitz are the elaboration of change models and impact models. Both models are discussed together because it is one of the outstanding characteristics of Geodesign that someone can get an immediate feedback on results of any changes to one of the systems used in a project are likely to be.
Change models were created based on three different input data: 1) Information on expected or desirable development of the campus that had already be collected by the core project team. For example, since years efforts have been spent to explore the potential of geothermal resources already used in the neighborhood of Osmanbey Campus. It is very likely that such resources can exploited in the near future and thus, allowing for new development of greenhouse projects and thermal therapy facilities of the existing university hospital. 2) Information included in an older master plan that has already become obsolete due to a missing sound data base. 3) Data created during a Geodesign workshop, which is explained in more detail below.

Workshop

Theoretically, as the used Geodesign Hub software is a web-based solution that supports the concurrent participation of many users a project could be carried out without a physical gathering of participants. Nevertheless, it has become good practice to organize workshops after the project has advanced to a point when evaluation models have been created. This is due to the nature of decision processes especially concerning major development projects. Decision-makers and heads of technical departments usually lack the required skills to use spatial decision support systems. The graphical user interface of Geodesign Hub might seem relatively simple for a professional GIS user whereas a decision-maker would see this very differently.

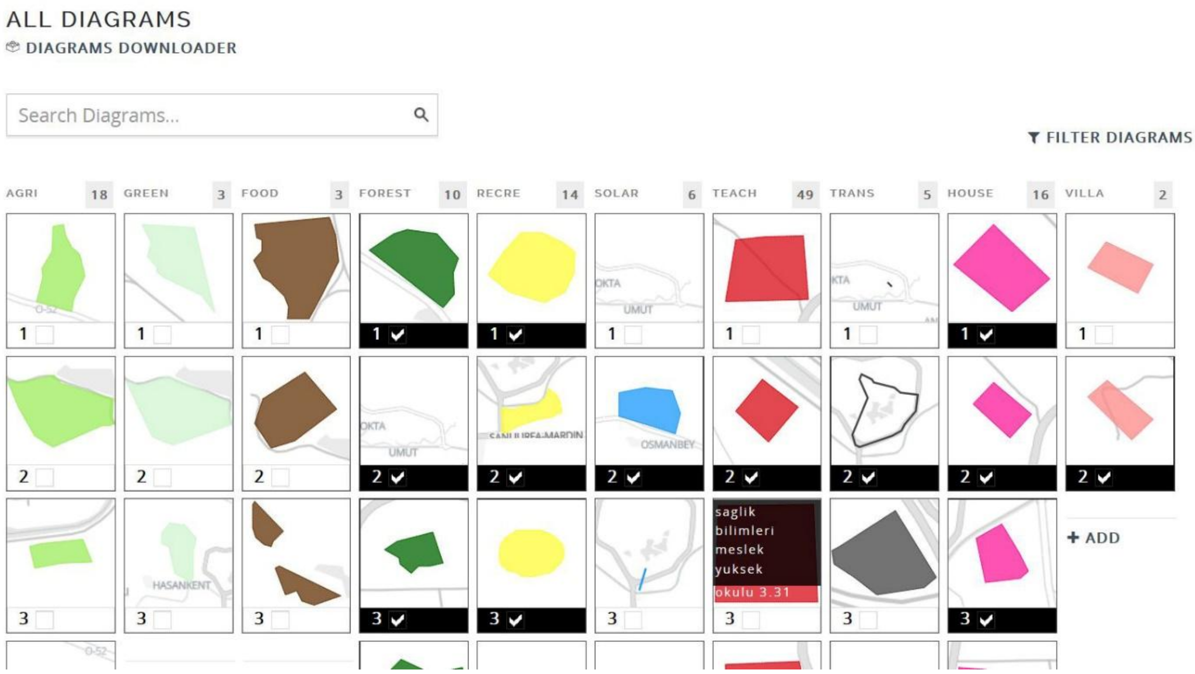

Figure 6. GUI of Geodesign Hub

The overall purpose of workshops was to bring together groups having different attitudes towards projects due to their different professions, interests and political orientation representing all important stakeholders in the area of interest. Following an iterative process, they had to come up with one or several optimized design for a new master plan. For this project, four groups were formed: an environmentalist, a developer, an educational, and an agricultural group. The groups were made up of decision-makers (deans of four faculties and several heads of administrative departments) and teaching staff.

During this workshop the following workflow was conducted:

Introductory presentation: As most of the participants had very limited or even no knowledge of spatial based technologies and the concept of Geodesign a short presentation of this subject was given. This included a summary of the most important features of Geodesign Hub.

Presentation of evaluation models and maps: Although quite some time had already spent of the optimization, the gathering of so many matter-subject-experts was a great opportunity to receive comments for further improvements. Works on it started after this workshop.

Creating of change diagrams: Diagrams are simple sketches of anticipated or intended changes to one of the 10 systems. Usually, they consist of bigger development projects like a new faculty building or an addition to the existing hospital. These diagrams were created directly digitizing with a mouse using the GUI of Geodesign Hub. Due to the limited time of the workshop (about 3 hours) some projects had been created beforehand. Thus, for each system an unlimited amount of change diagrams could be created. As a general rule, projects for a new system should be placed at locations having the highest suitability degree. They should address the results of the needs analysis. However, the participants were free to choose less suitable location if they felt a special need for it. A short excerpt is shown in Figure 6 above. Change diagrams were created by all groups concurrently.

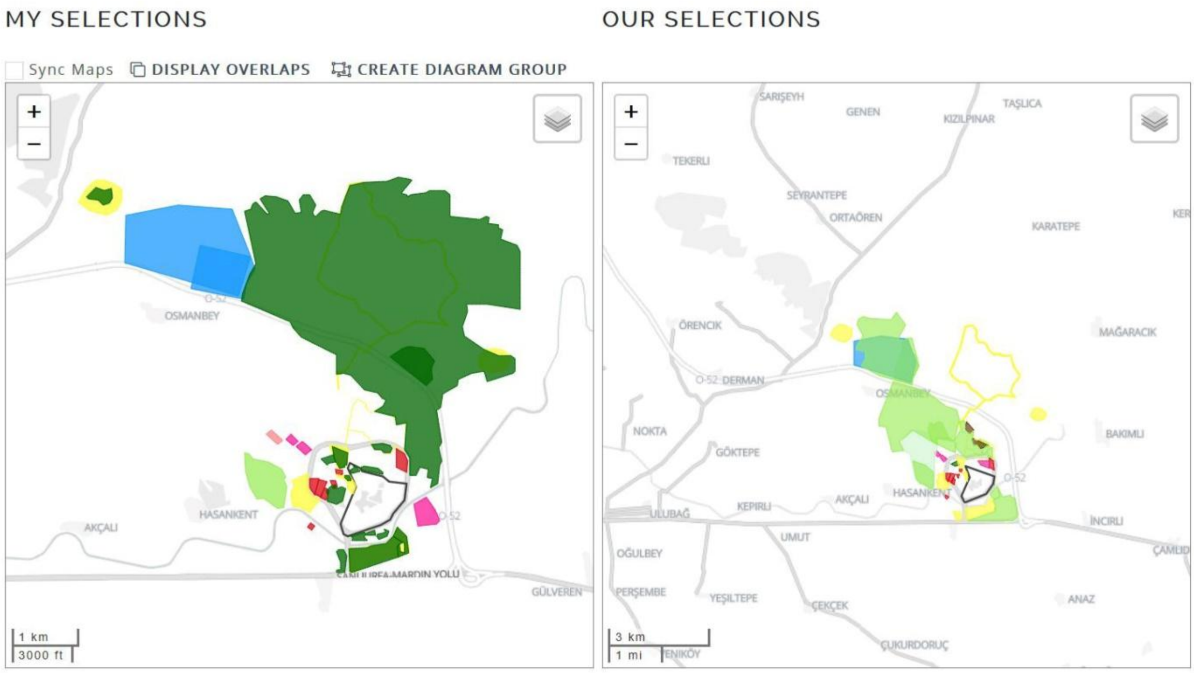

Figure 7. Excerpt of change diagrams created during the workshop.

Creating of impact models: By selecting the most suitable change diagrams each group generated one or more designs for a new master plan. During this process every group had access to all diagrams created by the different groups. This first selection process was characterized by mostly personal preferences. During the impact analysis, the percentage of projects for the 10 systems in relation to the total development area is computed. In addition, the impact analysis considers the impact that the change in one system has on all other systems classified into 5 categories: best, good, neutral, bad worst. This impact is shown as a graphic for all systems and an overall score is computed (Figure 7 and 8). Because many people are not very comfortable with 2d maps we offered the option to show the created projects in 3d embedded in a 3D model of the Osmanbey Campus using ESRI's CityEngine (Figure 9).

Refining change models: Using the impact summary for each system, projects that cause a more negative score can be addressed. By moving them to more appropriate locations as indicated on the evaluation maps the overall scoring can be improved. This circle of changing, reevaluation, and refining was repeated several times until each group came up with designs that satisfied them.

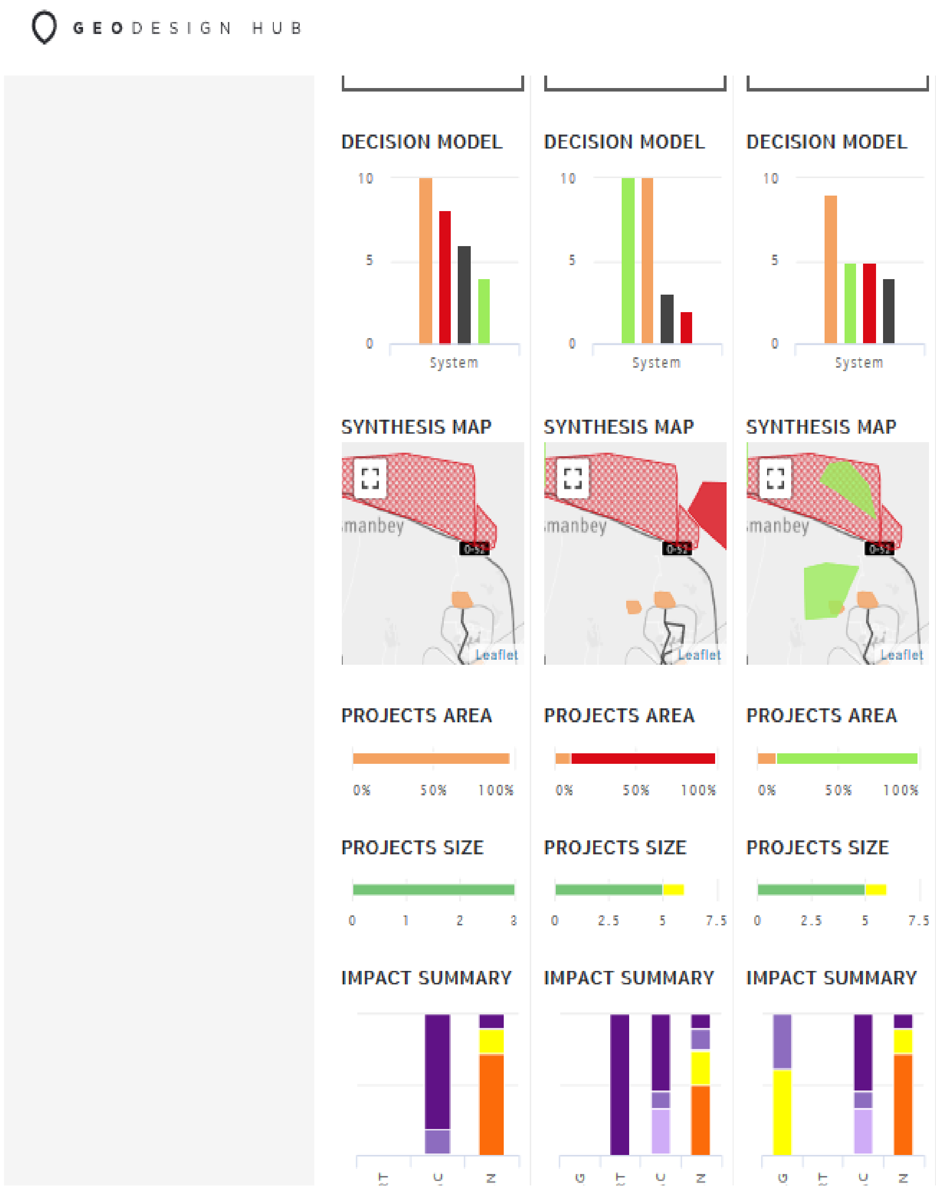

Figure 8. Overall score of impacts in Geodesign Hub

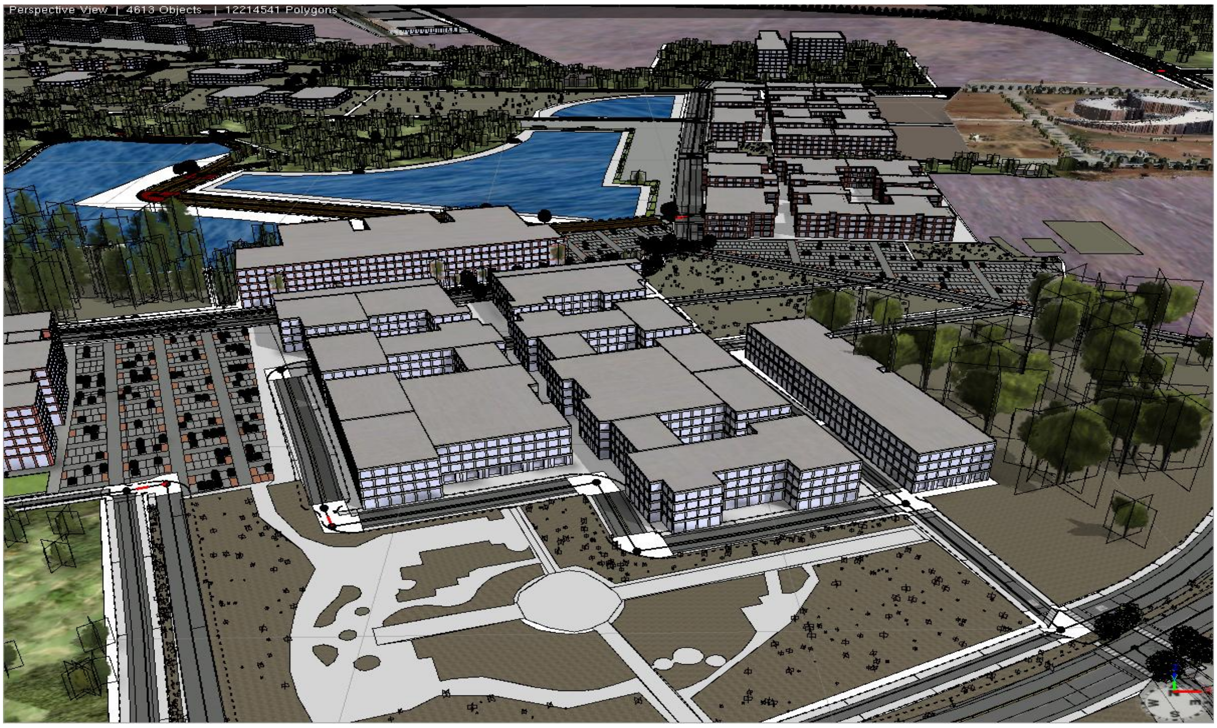

Figure 9. One proposed project in 3d embedded in a 3D model of the Osmanbey Campus

The last step according the Geodesign framework by Steinitz, creation of decision models, in which it is tried to find a consensus between the different interest groups and their developed designs, was not part of this workshop. It will be dealt with during the next workshop.

RESULT AND DISCUSSION

A new master plan for the Osmanbey Campus of HU following the Geodesign concept is underway. During the first two steps according to the Geodesign framework data and process models were created describing the current status of the natural and built-up environment in a very accurate way for the first time. This model served as an input for the creation of evaluation models based on the judgement of matter-subject-experts. Using the online tool Geodesign Hub, objective models based on scientific methodes could be combined with subjective evaluation models in a transparent way.

The most important step in a creating a new master plan was the establishment of change and impact models addressing the findings of the needs assessment that was conducted as part of this project. By means of a workshop the most important stakeholders were brought together to develop their own designs in an iterative way using the intuitive tools offered by Geodesign Hub.

CONCLUSION

Development of master plans, especially for university campuses, has much progressed towards the goals of sustainability in Turkey during the recent years. Still, the effective involvement of all stakeholders during an early stage of planning is missing causing an insufficient acceptance and low degree of implementation. Using the Geodesign approach for the development of a new master plan for the Osmanbey Campus of HU, the domains of scientific based fact finding and value based decision making could brought together. Instead of emotion loaded lengthy discussion as they prevail during hearings on major development projects, all stakeholder were enabled to create their own design following a well-documented transparent process that could be repeated by others. Thus, the best projects of other could be combined to achieve a more enhanced design of a new potential master plan.

The most striking feature of the used tool, Geodesign Hub, was that the participants of a workshop, in which new potential designs for a new master plan were created, could see the impacts of the individual projects that made up their designs immediately. By this, the time period usually required for reviewing and enhancing a master plan could be reduced from months to hours.

By definition, a master plan consists of two-dimensional maps and explaining reports. Because it is much easier for human beings to envisage a future scenario of their environment in 3D mode the option of displaying new project in 3D was much appreciated by the participants of the workshop.

Although the presented approach to master planning offers a lot of advantages compared to classical approaches there is much room left for improvements. Especially, two subjects should receive more attention in the future: 1) The conversion of evaluation models into evaluation maps is very cumbersome and time consuming. To speed up this process works on an interface that could automate this process have already started at the Department of Geomatics Engineering. 2) The display of projects in 3D has been done manually requiring the presence of a CityEngine professional. Using the existing API of Geodesign Hub the development of a user-friendly interface is desirable.

ACKNOWLEDGMENT

This study was supported by the Harran University Scientific Research Projects Unit [Project Number = 17002].

REFERENCES

[1] http://www.mevzuat.gov.tr/MevzuatMetin/1.5.3194.pdf 3194 Sayılı İmar Kanunu Erişim Tarihi: 19.02.2018.

[2] https://www.haberler.com/ataturk-universitesi-kampus-master-plani-10414215-haberi/ Atatürk Üniversitesi Kampüs Master Planı Ulusal Basın Haberi, Erişim Tarihi 20.02.2018.

[3] Asiliskender B., Yoney Baturayoğlu, N., (2017), *Fabrikadan Üniversite Kampüsüne: AGÜ Sümer Kampüsü, Mimarlık Almanağı* 2016.

[4] Oktay Özdal S., ve Küçükyağcı Özyılmaz P., (2015), *Üniversite Kampüslerinde Sürdürülebilir Tasarım Sürecinin İrdelenmesi, II. Uluslararası Sürdürülebilir Yapılar Sempozyumu (ISBS 2015), 28-30 Mayıs 2015*, Ankara.

[5] Kunzmann, K., 1993, *"Geodesign: Chance oder Gefahr?", in Planungskartographie und Geodesign, Informationen zur Raumentwicklung*, Bundesforschungsanstalt für Landeskunde und Raumordnung (Ed.).

[6] McHarg, I. L., & Mumford, L. (1969). *Design with nature*. New York: American Museum of Natural History.

[7] Steinitz, C. (2012). A framework for geodesign: Changing geography by design.

[8] Miller, W. R. (2012). Introducing Geodesign: the concept.

[9] McElvaney, S. (2012). *Geodesign: Case studies in regional and urban planning*. Environmental Systems Research Institute.

[10] Nyerges, T., Ballal, H., Steinitz, C., Canfield, T., Roderick, M., Ritzman, J., & Thanatemaneerat, W. (2016). Geodesign dynamics for sustainable urban watershed development. *Sustainable Cities and Society*, *25*, 13-24.