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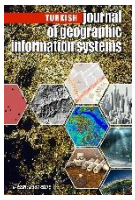

Creating development scenarios for Harran district/Türkiye with geodesign and financial analysis

Fred Barış Ernst*[1], İbrahim Yenigün[2], Esra Tuğalan[3], Songül Akdağ[4]

[1]*Harran University, Faculty of Engineering, Department of Geomatics Engineering, Sanliurfa, Turkey*
[2]*Harran University, Faculty of Fine Arts, Department of Architecture, Sanliurfa, Turkey*
[3]*Dicle University, Institute of Science, Department of Architecture, Diyarbakır, Turkey*
[4]*Harran University, Faculty of Engineering, Department of Software Engineering, Sanliurfa, Turkey*

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Abstract

Urban and regional planning in developing and developed countries faces many challenges, among them lacking support of stakeholders. Geodesign is a new approach in the framework of Public Participatory Geographic Information Systems addressing this problem. While Geodesign works have been carried out throughout the world they were separated from economic analysis. In this project, two different development scenarios for Harran District located in Southeast Turkey were elaborated using Geodesign methodology. Due to the importance of this region for agricultural production and its potential for tourism, the focus of this work lies on these sectors. The included financial analysis revealed the huge benefits of a scenario adopting early environmentally friendly technologies. The Net Present Value could be eight times higher if a conversion to orchards on some lands were realized. To streamline the computation of financial benefits on a strategic level an extension to the used GeodesignHub software was developed.

1. Introduction

"Geodesign" as a term was used by Kunzmann (1993) for the first time. Bibliographies (ESRI, 2019) reveals that it took another fifteen years until it was recognized as a new scientific approach, with which geography could be changed by design (Artz, 2010). Thus, Geodesign qualifies itself still as an innovative approach at the crossroads of geography, planning, landscape design and urban design. There is general agreement that in today's world of global competition the underlying cause for changing geography is rooted in economic profit. Astonishingly, no kind of financial analysis has been part of the ever increasing geodesign literature.

Without effective regional and urban planning, the biggest challenges of our century like population growth, climate change, environmental pollution and declining natural resources cannot be mastered considering ever increasing pressure on public budgets. However, in developed and developing countries, planning activities often do not fulfil expectations. This can be attributed to many factors, from which the still preferred 'top-down' approach plays a vital role (UNHABITAT, 2007; Polidoro et al. 2012; United Cities and Local Governments, 2010).

Missing or insufficient involvement of all stakeholders in the planning process results in resistance to implementing approved plans. Resistance can materialize in quite different forms, for example in Turkey, plans are continuously changed up to a point where they become obsolete (Kacar & Onay, 2015). As Dede (2016) reports planning decisions at different levels that have a spatial dimension do not have a chance to reach the stage of implementation. They are the product of desk studies fought over at court where due to inconsistencies they become rejected. In addition, Dede & Ayten (2012) list other bottlenecks of the Turkish planning system, among which they mention the lack of a planning vision that is shared among the stakeholders and a missing general cooperation between involved agencies.

And, according to a report of The World Bank (2015) missing coordination prevails during the preparation of strategic plans at regional, provincial, and local levels. When regional development agencies, provincial administrations, and Metropolitan municipalities

***Corresponding Author**

*(fr_ernst@yahoo.com) ORCID 0000-0002-7568-2582
(ibrahimyenigun@hotmail.com) ORCID 0000-0003-4742-0160
(esratgln@gmail.com) ORCID 0000-0002-9303-2866
(songul.akdag1995@gmail.com) ORCID 0000-0003-2278-4232

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prepare strategic plans they do not share a common platform.

To overcome this situation, in the 1960s a novel approach called 'Participatory Planning' emerged. As one of its trailblazers, Jane Jacobs (1961) coitized in her influential book 'The Death and Life of Great American Cities' that existing planning methods neglect the knowledge of the people of the place. To use a simple definition participatory planning can be described as an approach, 'in which everyone who has a stake in the intervention has a voice, either in person or by representation' (Rabinowitz, 2021).

In a recent study, Schindler (2016) evaluated planning activities that involved at least partially participatory planning methods including Sacramento's 2004 Blueprint Plan (SACOG, 2010) and Northwest Michigan's Grand Vision (The Grand Vision Coordinating Group, 2009). He concluded that with the promotion and advocacy of these plans by the general public and depending on the level of enforcement a compliance of up to 95 percent could be reached. Such a high number could be stated even though the framework of the respective regional plan was voluntary.

For adopting participatory planning in real life, a wealth of different tools has been developed and successfully implemented (Center for Community Health and Development at the University of Kansas, 2021). Among them, 'Public Participation Geographic Information Systems (PPGIS)', whose term was coined at the meeting of United States National Center for Geographic Information and Analysis (NCGIA) in 1996, play a significant role (Nedjeljko, 2011). Classical Geographic Information Systems (GIS) have been a standard tool for regional and urban planning for decades. While widely used by professionals in the related fields they lacked intuitive user interfaces that allowed for the participation of the general public. With the arrival of Web 2.0 this situation has changed with many web-based PPGIS being available now. For example, "GeodesignHub" (GDH) (Ballal, 2015), which includes an option for adding costs and available budgets to the planning process, was released in 2015.

Its theoretical background is based on the textbook 'Framework for Geodesign' published by Carl Steinitz (2012) who has been working with his colleagues and students for more than 30 years to develop the GIS rooted methodology Geodesign. With it, he could close the gap that existed between the scientifically based analysis tools and databases of GIS and the design tools that were favored by architects, designers, and planners. Geodesign fosters the collaboration of all stakeholders including state agencies from different administration levels, private companies, and the general public.

With GDH, the 'Steinitz framework' has been converted into a digital representation of a planning workflow, which has been applied in many workshops for testing purposes (Rivero et al., 2015; Ballal, 2015; Nyerges et al., 2016). Then, this software has been successfully integrated into many planning efforts in various parts of the world (Campagna et al., 2016; Moura et al., 2016; Kim, 2017). Ernst et al. (2019) described the design of a new master plan for the campus of a university located in Southeastern Turkey based on Geodesign. GDH software helped to create several scenarios for a 3000-ha campus, in which all stakeholders of the university were involved. In Sydney, Australia, existing silos between different governmental agencies have been broken down by engaging their representatives during GDH workshops (Pettit et al., 2019). They aimed at overcoming coordination problems between these agencies that hindered the planning and timely implementation of megaprojects in Southeast Sydney.

Already in 1959, urban planner P.A. Stone stated, "The choice between alternative plans must be based on the trinity of appearance, function and cost." While urban competitiveness – environmentally, socially, and especially, economically - has become one of the central issues in urban planning today (UNHABITAT, 2013), the inclusion of financial parameters in the Geodesign methodology has only recently drawn some interest. Although even in "A Framework for Geodesign" (Steinitz, 2012) the importance of "economic geographies" is mentioned there is no literature available, in which the impact of economics is dealt with from the viewpoint of Geodesign. In 2021, the "DesignKPI" plugin, which is hosted on the GitHub platform (GitHub, 2022), was added to GDH. The purpose of this plugin is to add financial scenarios to the designs created in GDH. Until now, no research on Geodesign that made use of this plugin has been published.

The purpose of this ongoing project is to develop different development scenarios for Harran District following a participatory planning approach with the addition of a quantitative financial analysis, which is new in the field of Geodesign. The work has been carried out using the PPGIS web-based platform GDH. Out of 5 planning scenarios (non-adaptor 2050 (NA 2050), late-adaptor 2035, late-adaptor 2050, early-adaptor 2035, and early-adaptor 2050 (EA 2050) (Ernst et al., 2021), only the NA 2050 and the EA 2050 have been explained in this paper. Due to space constraints, we focused on the two most diverging development alternatives: a business-as-usual scenario and a portfolio of projects pacing a way to an economically, and ecologically sustainable development. Even though the focus of this research lays on the optimum location and selection of projects according to a set of spatially related criteria, cost is a factor that cannot be neglected. The included cost-benefit analysis does not claim to be an in-depth financial analysis rather than indicating the economic consequences that major development decisions would bear.

The research area of this project covers Harran District in Şanlıurfa Province that is part of the Southeastern Anatolia Project (GAP), one of the world's biggest irrigation and development projects (Unver, 1997). Besides its potential for agricultural production the region stands out for its unique archaeological heritage, from which the UNESCO World Heritage site Göbeklitepe located in Şanlıurfa's Haliliye District with its first spiritually used stone monuments reaches back 11 500 years (Hackley & Gopher, 2020). In the Middle Ages, Harran was competing with Bagdad for being the cultural center of the world. Despite this glorious past and the big investments made so far Şanlıurfa Province

still counts for the poorest province of Turkey in terms of GDP per capita (2901 USD, Turkish average: 8598 USD (TÜİK, 2021a)).

Harran District has been chosen as a research area for several reasons: 1) Archaeology/Tourism: The famous "Harran School" established in the seventh century CE and considered to be the start of the Golden Islamic Age (Menemencioglu, 2007) had a major impact on the increase of knowledge during this age and its proliferation to the West triggering the epoque of renaissance. The literature originating from this school counts in thousands including inventions in mathematics, astronomy, and medicine. In contrast to Göbeklitepe, which essentially is made up of some big stones only, Harran's big cultural heritage has not been approved as a UNESCO World Heritage Site yet (UNESCO, 2022). Correspondingly, tourism still plays a very low role in the local economy. 2) Agriculture: The greatest part of Harran Districts lies in the Harran plain having one of the most fertile soils of Turkey with abundance of water for irrigation provided by the near-by Atatürk Dam. Disregarding the semi-arid climate, harmful agricultural practices comprising inappropriate irrigation and wrong plant portfolio has caused the salinization of soils. Due to socio-economic conditions such harmful practices continue despite the well-known fact that they were one of the main causes for the decline of early civilizations in Mesopotamia (Al-Hayali, 1964). In addition, wasting fertile soil by uncontrolled settlements has become a major concern. 3) socio-economic conditions: According to official statistics Harran District had one of the highest rates of analphabetism of all Turkish districts (7.7 compared with 2.5 for Turkey (TÜIK, 2022a)) and in 2017 one of the largest household sizes (8.44 (Karacadag Development Agency, 2018)) of Turkey (average 3.45 (TÜIK, 2022b)). These numbers indicate the prevalence of feudalistic structures in one of the least developed parts of Turkey.

This project was initiated by members of the Metropolitan n Municipality of Şanlıurfa who wished to see a more sustainable development of its district city Harran. At the same time, an area exhibiting great development potential paired with high constraints like Harran District makes it attractive for research of future projections. Especially, if Harran's current conditions are compared with its twin city in Italy, Alberobello. Despite some similarities like its rural setting its clear development path differs from Harran: Mainly due to its conserved "Trulli" architecture (like the beehive houses of Harran) it has become a UNESCO World Heritage Site in 1996 and attracts now about 2 million tourists a year.

2. Method

2.1. Geodesign

Originally, it was planned to carry out this project in close cooperation with the Metropolitan Municipality of Şanlıurfa and the Municipality of Harran by means of conducting several workshops. However, due to the pandemic most of the works were carried out during a master class of Geodesign via distant learning at Harran University, Şanlıurfa. As this project was submitted to the International Geodesign Collaboration (IGC, 2021) it had to adhere to its standards including a 40 x 40 km research area that does not exactly match the district boundaries,

During this project, the methodology as described by Steinitz (2012) in 'Framework for Geodesign' and summarized in the schema below was followed.

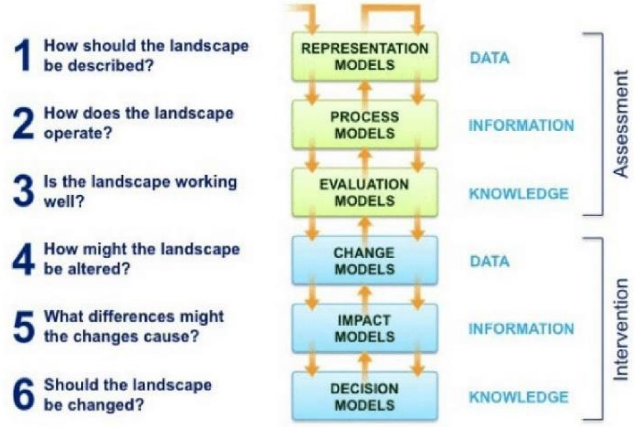


Figure 1. Geodesign framework by Carl Steinitz (2012) consisting of six phases that must be passed three times

2.1.1. Representation models

During the last few years, several development plans that have been especially targeted the Harran District itself or the related Şanlıurfa Province have been written, like the Harran Management Plan 2016 (Anadoku, 2016) and the GAP Region Tourism Master Plan (Barlas Zoning Planning Consultancy Company ,2016). While these plans provide useful information about general development strategies and especially, for the tourism sector detailed proposed project descriptions, they rarely show detailed maps of the current situation and even more important, where such projects should be located. In order to enable analysis that have a sound spatial background a comprehensive GIS database spanning ten sectors that represent sufficiently the research area (agriculture, energy infrastructure, green infrastructure, industry and commerce, institutional, urban development, transport infrastructure, water infrastructure, tourism and archaeology (naming and amount of sectors according to International Geodesign Collaboration standards (IGC, 2021)) had to be built. Raw data have been obtained from the Metropolitan Municipality of Şanlıurfa and different departments of Harran University and processed for the purposes of this study.

2.1.2. Process models

While representation models deal with the current state of the different systems and related subsystems for the respective study, during this step it is tried to model the most important processes that result of the interactions of these systems with each other in each period. For one of the most important systems, agriculture, the combination of the subsystem soil (mostly clay), subsystem climate (semiarid) and subsystem land use (permanently irrigated land with

wrong irrigation practices) has caused the salinization of thousands of hectares of soil in this area. For this process, the already existing soil salinity map produced by Harran University's Department of Soil and Plant Nutrition (Çullu et al., 2010) has been made use of.

2.1.3. Evaluation models

In order to evaluate how well the ten sectors are currently working they have been classified according to their suitability to support the planned new projects. For these evaluation models the requirements for the following change models must have already been defined. Here it becomes evident that in order to conduct a Geodesign research successfully the above mentioned three passes of the Geodesign framework must be completed.

As an example, the classification sheet for the agriculture sector is displayed in figure 2, in which a color palette from dark green to red indicates the suitability for location of new projects. During the first and second passes of this study, it was decided that changes in the agricultural sector should focus on extending orchards. As the anticipated plant species to be used are extremely sensitive to soil salinity, this soil characteristic had to be included in the list of criteria for the respective suitability map (Figure 2).

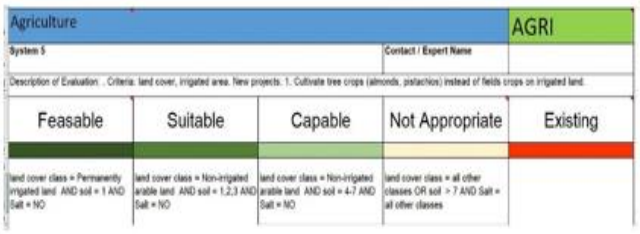


Figure 2. Evaluation sheet for the system agriculture focusing on projects for new orchard plantations, which forms the basis for the creation of a suitability map for the respective sector

Criteria that were used for this sector are quality of the soil, irrigation, and salinization. For each of these criteria a digital map was created from existing sources and then, according to the above-made logical statements these maps were combined into one final map by means of an overlay analysis. No weighting scheme was applied.

2.1.4. Change models

During this step, changes to the systems that were the subject of this study were proposed. Such changes can be made of new regulations like conversion to a protected area (not considered in this study) or major projects. For this, projects are drawn against the background of the suitability map of the respective system preferably on the most suitable lands shown as dark green color in figure 3. In our case, over 90 projects were created prior to the workshop. However, using the simple drawing tools of GDH they can easily be designed during a workshop as well.

While working on 'Change Models' major projects represented as diagrams in GDH must be created with the purpose of meeting development requirements for the above mentioned 10 sectors based on area (ha). Figure 3 shows a screenshot of the GDH system with projects created for some of the sectors and enlarged, the details for a new pecan plantation project from the agricultural sector.

Some of the projects taken from the "Harran Management Plan" (Anadoku, 2016) are as follows: Determination of Camping Areas, Equestrian, Cycling and Nature Hiking Routes in Harran and Its Connection Points; Harran Great Mosque, Harran Mound and Inner Castle Excavation; Han-El Ba'rur Caravanserai Excavation and Restoration; Shuayip City Ruins Excavation and Restoration; and Restoration Works for Beehive Houses and Functioning for Tourism.

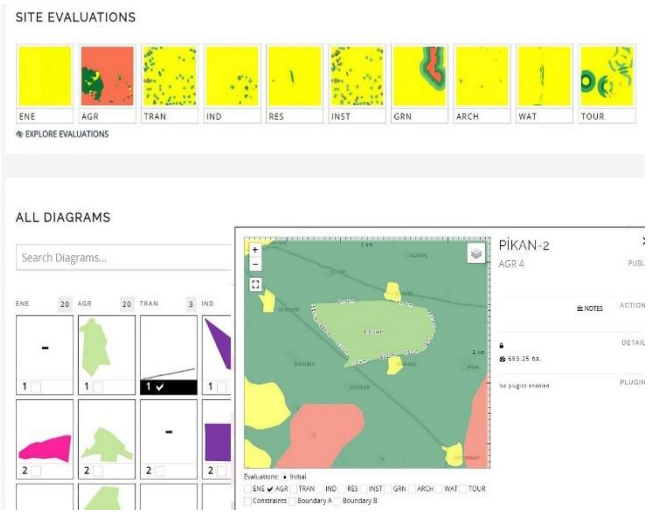


Figure 3. Part of graphical user interface (GUI) of GDH showing suitability maps for all systems ("SITE EVALUATIONS" in the upper part) and some projects for the systems energy, agriculture, transportation, and industry (lower part, left side) and the details of one project (pikdan-2) drawn against the suitability map for the respective sector (agriculture) (lower part, right side)

2.1.5. Impact models

Using the Geodesign platform GDH, impacts of proposed projects on the system, to which they belong (meaning how well they were placed on the respective suitability maps), or all the other systems (cross-systems impact) are computed on the spot. This computation is executed based on the Cross System Impact matrix, in which impacts have been defined by subject-matter experts during the second pass through the Geodesign framework (Figure 4).

'Impact Models' will reveal whether and to which degree the created projects will have negative impacts on projects of other sectors. For example, a planned new photovoltaic (PV) power plant might take away space allocated for grazing land and thus, will have a negative impact on the sector 'agriculture.' As a result of 'Impact Models', the first selection of projects will undergo their modification or even deletion from the list of candidates for scenarios to be built in the next phase.

Figure 4. Cross System Impact matrix with columns because the inflation rate has a significant impact on it and all our computation have been made on a EURO basis. The discounting factor has been computed as follows

$$1/((1 + \$AI\$5)^2 E4 \quad (1)$$

whereby AI5 refers to the Weighted Average Cost of Capital (WACC) in the table and E4 to the mid-year discounting (see below).

For WACC, which is one of the most important parameters when computing the NPV, beta values have been taken from NYU Stern (Damodaran, 2021) for the following sectors: "Farming/Agriculture", "Homebuilding", "Food Processing", "Hotel/Gaming", "Green & Renewable Energy", "Transportation (Railroads)". Rf and Rm values were derived from Market-Risk-Premia (2022) and computed according to the formula representing the existing condition for a system and rows the in-tended change to a different system. Five colors ranging from dark green (most positive) to red (most negative) indicate the nature of an impact for a respective change.

2.1.6. Decision models

Depending on the special methodology defined during the second pass of the Geodesign framework, stakeholders gather to discuss options for further development of a region and if possible, to reach an agreement on the optimal solution. While these activities are usually implemented by means of one or several workshops under the participation of decision-makers until now, such a setting could only be simulated by means of a virtual workshop.

During the face-to-face or virtual workshop, stakeholders are combined into major interest groups that develop their own scenarios under usage of projects created during the previous two phases. Finally, they come together in order to reduce the number of scenarios until preferably, they can agree on one optimal solution. Figure 5 presents one of the tools that facilitate such negotiations.

2.2. Development of an interface for financial analysis

Figure 5. Tools of GDH that facilitate negotiation for achieving one common scenario. In this case only projects, for which disagreements exist are shown in table (left side) and map format (right side)

The purpose of the financial analysis was to calculate the Net Present Value (NPV) for each project's investment because it is commonly used to analyze the profitability of an investment project. At the beginning, all financial data had been entered into the existing API DesignKPI for GDH. As the results were not accurate enough, we developed our own application that was linked to GDH via its API. In a first step, a MS Excel sheet (table 1) for calculating the Discounted Cash Flow (DCF) for each project was set up. It comprised Capital Expenditure / Initial investment (CAPEX), Expected Annual Revenue, Annual Operating Expenditure (OpEx) and Other Expenses (like maintenance). For a more detailed analysis, after having set the values for Expected cashflow growth and Weighted Annual Cost of Capital (WACC) the sheet computes the values for Total Discounted Cashflow and the NPV.

For the growth rate 3 % of cash flows has been used.

$$\text{Cost of Equity} = (\text{Rf} + (\text{beta} * (\text{Rm} - \text{Rf}) \quad (1)$$

in which Rf corresponds to the interest rate. They reflect the status of August 2022 (Rf = 12,6 and Rm = 10,7). N stands for mid-year discounting. Since the cash inflows and outflows occur continuously year-round, it is inaccurate to assume that the cash proceeds are all received at the end of each year. As a compromise, mid-year discounting can be integrated into DCF models to assume that FCFs are received in the middle of the annual period (Dobner, 2002).

In this research, the financial analysis covers 30 years (2021 to 2050) for all projects, and it has been assumed that all projects would start in 2020. A life span of 30 years is realistic because projects in the sectors of tour-ism, transportation, energy, and urban development usually have such a life cycle. Even in the agricultural sector, the chosen tree crops would surpass this period. On the other hand, we are aware that it is an unrealistic assumption that all projects would start in the first year. As setting priorities for projects is a highly political question, we avoided to be presumptuous on this subject and stretched investments over this time horizon only for the tourism sector. Anyway, the DCV

calculation has been set up in a way that makes any modifications on the start date of investment and annual revenue quite easy.

In order to make the process of calculating financial impacts as user-friendly as possible (one of the principles of Geodesign) a special interface was developed (figure 6). This was accomplished by building an interface programmed with Spyder (Python 3.9) using the API offered by GDH. The GUI for user input was developed with Python's Tkinter library and Python's Matplotlib library for the required computation processes. The previously defined parameters and formulas of the MS Excel spreadsheet as shown in table 1 were transferred to this application.

Table 1. Part of Discounted Cash Flow (DCF) sheet (example for a 5* hotel) covering the first seven years of a 30-year period

Year	2021	2022	2023	2024	2025	2026	2027
N	**0,00**	**0,50**	**1,50**	**2,50**	**3,50**	**4,50**	**5,50**
Investment (in €)	-3.100.000	-3.090.000	-2.120.000				
Free Cash Flow before OpEx (in €)				3.600.000	3.708.000	3.819.240	3.933.817
Operating Expenditure (OpEx) (in €)				520.000	520.000	520.000	520.000
Other Expenses							
Discounting Factor		0,95	0,87	0,79	0,72	0,65	0,59
	0	1	2	3	4	5	6
Total Free Cash Flow to Investment (in €)	-3.100.000	-3.090.000	-2.120.00	3.080.000	3.188.000	3.299.240	3.413.817
Present Value of Cash Flow (in €)		-2.946.199	-1.837.582	2.426.996	2.283.726	2.148.557	2.021.066
Initial Investment (in €)	-3.100.000						
Sum of Cash Flows (in €)	28.024.494						
Present Value of Investment (NPV) (in €)	24.924.494						

Area sizes for selected projects in GDH are read automatically and with the interface as shown in figure 6 the required financial parameters can be entered. The output is a graphic that displays the most important parameters as can be seen in the graphics further down.

Figure 6. Interface for financial analysis with fields for entering the most important parameters to calculate DCF and NPV

2.3. Assumptions and requirements for the most important sectors

Following the conventions of the International Geodesign Collaboration (IGC, 2021) ten systems had to be included in the Geodesign analysis. However, the economic indicators of table 2 point to the fact that for Har-ran, under the current situation and the scenario that assumes "business as usual" for the future only two sec-tors are relevant (if public administration that is concentrated in the province capital is disregarded): agriculture and services (including tourism). Unfortunately, no numbers were available at the district level. According to the authors' knowledge, for the Harran District all other sectors do not play a significant role and even the percentage for services (in the case of Harran mainly tourism) most probably, is much lower than for Şanlıurfa.

Table 2. Gross domestic product by provinces by economic activity for Şanlıurfa Province for the year 2020 (from TÜIK 2021b)

Sector	% GDP
Agriculture, forestry, and fishing	25
Industry	12
Manufacturing	8
Construction	5
Services	17
Financial and insurance activities	1
Real estate	6
Public administration incl. Education and health	26

On the other side, for the future EA 2050 scenarios it is expected that in addition to the agricultural sector, major changes will happen also in the Urban Development, Archaeology/Tourism, Energy Infrastructure and Transportation Infrastructure sectors. Only these sectors are dealt with in more detail in the following para-graphs.

Green infrastructure thar refers to public gardens and parks, protected natural and semi-natural lands (range-lands) are shown on the maps due to their huge spatial coverage. As they play a minor role in the local econo-my, this study has not addressed them. For the same reason, Industrial/Commerce, Institutional and Water In-frastructure are shown on some of the maps. They mainly relate to future scenarios and its financial impacts could not be computed in this study.

2.3.1. Agricultural sector

The main differences between NA 2050 and EA 2050 for this sector become apparent if the different crop portfolios are regarded as shown in figure 7.

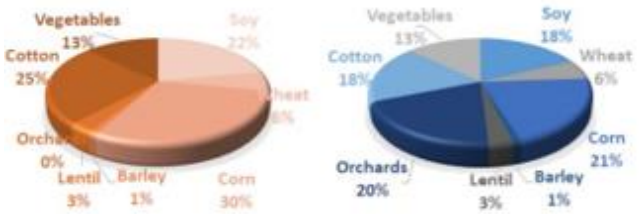


Figure 7. Crop portfolios for creation of scenarios for the agricultural sector (left side: NA 2050 and right side: EA 2050)

Under the NA 2050 scenario cotton would continue to be cultivated on 25 % of the irrigable land. If costs for energy, water, fertilizer, and pesticides are considered a yearly total cost of 2450 €/ha has been assumed based on current prices. From this, current governmental subsidies of 595 €/ha must be subtracted (National Cotton Council, 2020). Current revenues computed on a hectare basis average 2650 €/ha.

For EA 2050, only the conversion of 20 % of irrigable land (corresponding to 10 000 ha) to perennial plants as it was the original target of the GAP plan (USIAD, 2008) has been considered. Other changes like sustainable management of rangelands and tree plantations without irrigation have not been considered because their economic impact will be very limited. For this, plantation of pecan trees (Carya illinoinensis) has been chosen because they are well adapted to the dominating ecological conditions of the region (T.R. Ministry of Agriculture and Forestry, Directorate of Western Mediterranean Agricultural Research Institute, 2009). Pecan trees will produce nuts economically sufficient only six years after being planted. Then, they will generate on aver-age a yearly revenue of about 14 750 €/ha for a period of at least 50 years while costs sum up to 2200 €/ha. Due to missing official numbers for Turkey, the sale price for farmers was calculated using Internet resources (Pecan Nut Prices, 2021) and the ratio of sale price for farmers to retail prices was assumed to be the same as for walnuts resulting in 3,40 €/kg. International figures were taken from the latest reports of US Department of Agriculture (Rafanan, 2021) indicating a price of about 3 €/kg. Because farmers would receive no benefit from planting pecan trees during the first years it is assumed that the same number of subsidies as for cotton would be paid to those farmers during this period. As costs for planting and maintaining a pecan orchard in Turkey were not available the respective numbers have been obtained from a walnut farm producing under similar conditions (Taştan, 2013).

2.3.2. Tourism Sector

Under NA 2050, local tourism activities will only marginally increase due to an inappropriate urban development and a missing tourism infrastructure. Overnight stays of tourists will be arranged by travel agencies in nearby cities like Gaziantep and Şanlıurfa and thus, the benefit for Harran's economy will remain limited. Only restaurants (with a total of 17 new ones) will take profit of these visitors experiencing a moderate growth corresponding to the rate before the pandemic i.e., 5 % per year totaling about half a million visitors in 2050.

In contrast, EA 2050 will take profit from a positive urban development as described in the respective paragraph below. Huge investments in the tourism sector are aimed at 2 million visitors per year, a quarter of them staying overnight. The investments are characterized by the following: 1) Careful restoration of the archaeological sites in and around Harran City and removal squatter settlements from the Harran tell, 2) Building of a 5-star hotel, 3) Construction of 18 hotels according to the “boutique hotel” principle, 3) Development of the gastronomy sector including 40 different facilities, 4) Establishment of six visitor centers in and around Harran City, 5) Setting-up of bicycle routes with 12 traditional tent camps for overnight stays, 5) Setting-up of hiking trails, and 6) Establishing a college for tourism. All costs are based on the guidelines of the Ministry of Environment and Urbanization (Construction Approximate Cost, 2021).

2.3.3. Energy sector

According to the World Bank Group (Suri et al., 2020) due to favorite climatic conditions a high potential for energy production by means of photovoltaic (PH) plants exists in the region. Especially, in the Southern foothills of Tektek Mountains, sufficient locations for the construction of plants that would make Harran District independent in terms of electric energy can be found. However, as of 2021 almost no photovoltaic plants exist in Harran District and due to the current structure of governmental subsidies (Karacadag Development Agency, 2014) this is not expected to change under NA 2050. On the other hand, one of the requirements of EA 2050 is to become energy-wise a self-sufficient district. The required amount of PH plants for 150 000 persons might be realized if the political will exists. It is expected that prices for solar panels will drop by 63% by 2050 (Solar AVM 2021; The Solar Nerd 2021; Global Solar Atlas, 2021).

2.3.4. Urban development sector

The urban development sector plays a key role in this study because how it will evolve over time will impact all other sectors especially tourism, archaeology, transportation, agriculture, and energy. Current conditions that are assumed to continue under NA 2050 are characterized by 1) standard exterior design without insula-tion and ignoring the cultural heritage of the region, 2) ongoing encroachment of the archaeological site of Harran City and other locations by squatter settlements, 3) agricultural activities (especially animal husband-ry) within Harran City, and 4) approval of encroachment of new subdivisions onto fertile lands around Harran City.

All these features will hinder the growth of the tourism sector to become a pillar of Harran's economy. There-fore, it can be doubted that expected population numbers can be supported in terms of employment and con-sequently, the already existing emigration into bigger cities will continue. On the other hand, a carefully planned and implemented urban development under EA 2050 would regard the cultural heritage, the protec-tion of fertile lands and support their conversion into orchards and thus promoting tourism, sustainable agri-culture and a related food processing, light industry. These economic activities would sustain a growing popu-lation, which mainly would live in a new satellite city accommodating about 50 000 persons covering an area of 350 ha. It would be located at the foothills of Tektek Mountains 15 km distant to Harran City without occu-pying fertile lands of the Harran plain and a connection with light rail to Harran City and Şanlıurfa would be feasible under this scenario. Costs for such a new satellite city, including the required infrastructure, have been computed using the guidelines of the Ministry of Environment and Urbanization (Construction Approxi-mate Cost 2021).

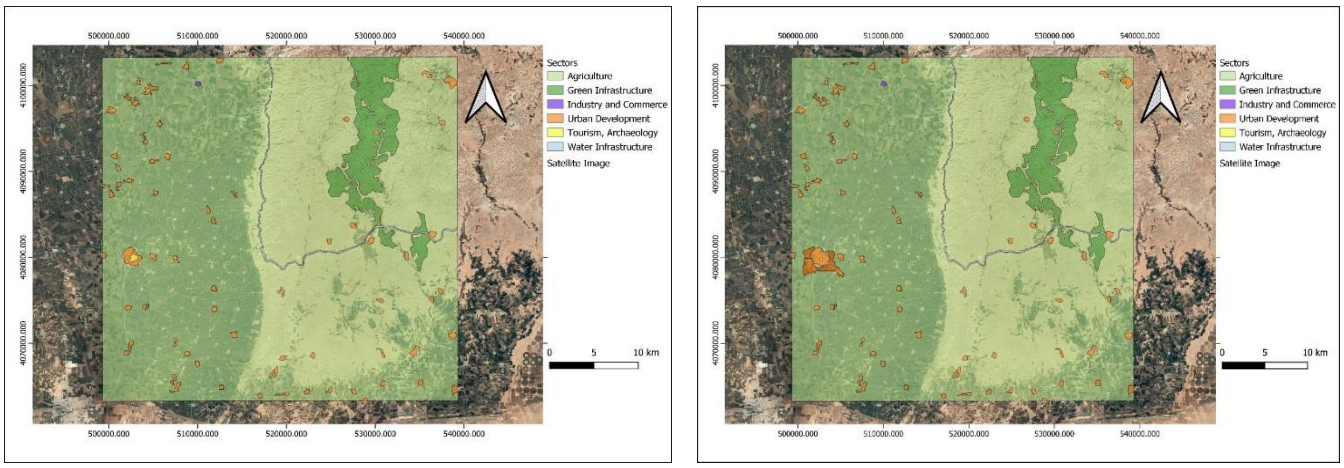
2.3.5. Transportation sector

Currently, only fossil fuel powered private and commercial vehicles are used. Coaches of private companies bringing tourists to Harran are starting to cause parking problems. The district road connecting Harran with the Şanlıurfa - Akçakale road consists only of a two-lane road in bad condition. However, the General Directorate of Highways (KGM) has reserved enough land adjacent to the Harran district road that would allow the up-grade to a four-lane road and the construction of a light rail line from Harran to Şanlıurfa. There, a connection to the Turkish high-speed rail network would exist from 2030 on. Whereas under NA 2050 no major changes are expected to happen, under EA 2050 several projects to reduce the dependency on private vehicles, to de-crease traffic volume around Harran City and Şanlıurfa and to minimize travel time for commuters are envis-aged.

3. Results

The map in figure 8a gives an overview of the research area's current situation. Nearly all the land is used by agriculture. The dark green color indicates the national park 'Tektek Mountains' where intensive grazing is a frequent practice. The yellow spot within the settlement area of Harran City represents the archaeological site of Harran.

When compared with the above map, NA 2050 's map in figure 8b does not exhibit many differences due to ongoing, unchanged practices in all major sectors. Changes will arise mainly in and around Harran City, which result from inappropriate urban development. On one side, the encroachment into fertile lands around the city by planned new subdivisions and on the other side into the archaeological site by squatter settlements become apparent.



(a) (b)

Figure 8. (a) The research area's current situation including the most important sectors against the background of satellite imagery from Google Earth. Due to scaling reasons Tourism and Archaeology sectors have been combined into one class, (b)The research area showing the NA 2050 scenario including the most important sectors for this scenario against the background of satellite imagery from Google Earth. Due to scaling reasons Tourism and Archaeology sec-tors have been combined into one class

In contrast, the map of EA 2050 of figure 9 displays a vastly different picture characterized by the following features: 1) The brown areas around Harran City represent new plantations with pecan trees that will give Har-ran the appearance of a garden city. 2) The archaeological site has even slightly increased in size caused by the removal of squatter settlements. Other changes for the tourism sector cannot been detected due to the map scale. 3) At the edge of the Tektek Mountains a new satellite city with an industrial area in the North has been founded. 4) A light rail connection from there via Harran City to Şanlıurfa has been built. 5) In the eastern part of the research area all rangelands are managed in a sustainable way.

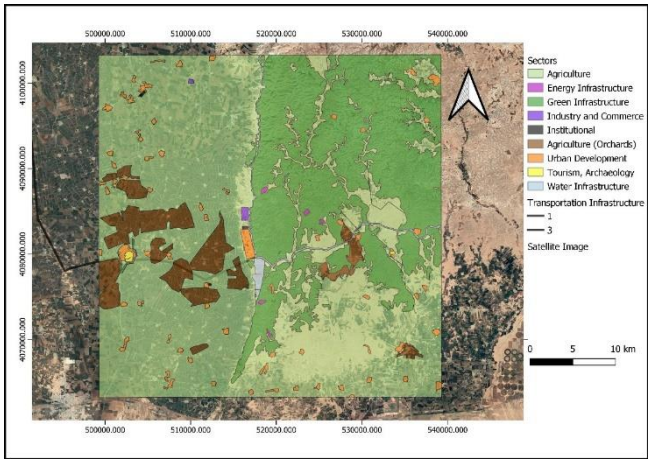


Figure 9. The research area showing the EA 2050 scenario including all ten sectors for this scenario against the back-ground of satellite imagery from Google Earth. Due to scaling reasons Tourism and Archaeology sectors have been combined into one class. For a better understanding of planned agricultural innovations Agriculture (Or-chards) has been added as a separate class

Both scenario maps, NA 2050, and EA 2050, are the results of the selection of single projects and their combination to form scenarios that meet a set of predefined requirements. Whereas in the case of NA 2050 'business as usual' including only some minor changes has been assumed, for EA 2050 major projects requiring big investments have been created. For the selection and location of these projects the most important criterion was to minimize negative impacts on other sectors. For example, the foundation of a new satellite city would have caused less costs for the required infrastructure if a location nearer to the existing city had been chosen (One additional kilometer of the light rail sector equals 8 500 000 €) (Şenlik, 2013). However, this would have happened at the cost of building on fertile farmland. A summary of the financial analysis for both scenarios is given in table 3.

Table 3. Summarized economic analysis for NA 2050 and EA 2050 scenarios for the most important sectors

	NA 2050			EA 2050		
Sector	**Total Investment**	**Sum of Cashflows**	**NPV**	**Total Investment**	**Sum of Cashflows**	**NPV**
Agriculture	-17.084.550€	116.697.171€	99.612.622€	-15.657.000€	816.776.910€	801.119.910€
Tourism	-6.071.043€	60.787.747€	60.252.067€	- 35.305.622€	389.625.872€	382.341.058€
Urban development	- 232.327.789€	320.754.555€	108.754.555€	-416.100.000€	312.750.986€	96.650.986€
Transportation	NA	NA	NA	-432.000.000€	-11.966.477€	-99.966.477€
Energy	NA	NA	NA	-14.677.500€	159.951.946€	145.274.446€

The greatest monetary impact on the future development of Harran province if EA 2050 were chosen will come from projects in the agricultural and tourism sectors. In order to get a better understanding of these numbers below, the details for some projects are shown.

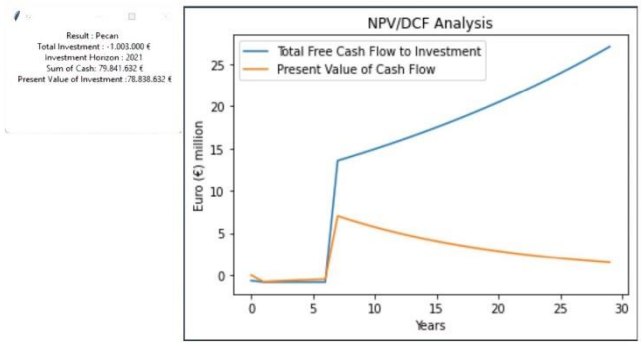


Figure 10. Financial analysis of a new pecan plantation project covering an area of 590 ha

Figure 10 shows the performance of a new plantation of pecan trees covering a project area of 590 ha. While investment costs are extremely low due to low wages and prices for tree saplings, revenues starting from year 7 are remarkably high due to a high demand on national and international markets (Bailey, 2021) resulting in a NPV of 78.838.632 €. If instead, the same area is used for cotton cultivation as in NA 2050 the results shown in figure 11 indicate that with 8.050.343 € the NPV is relatively low and without continued governmental subsidies might turn into losses easily. Since for these kinds of agricultural activities costs can be computed based on area for all planned pecan plantations (9210 ha) an NPV of about 801 million € compared with a NPV for cot-ton production of only 99 million € can be expected.

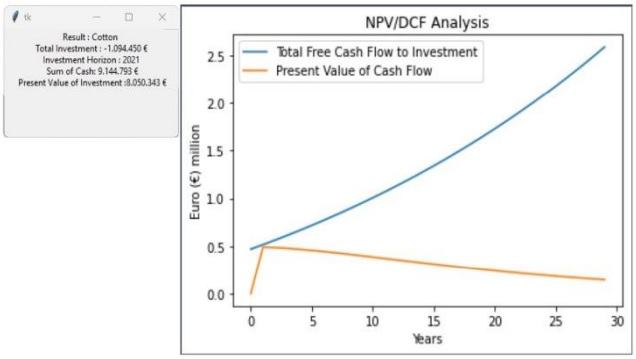


Figure 11. Financial analysis for a cotton plantation covering the same area as the pecan plantation shown in figure 11 (590 ha)

In the related sensitivity analysis growth rates of cash flows from 0 % to 5 % and WACCs from 8 % to 17 % have been chosen. The results suggest a great variability in the PVI ranging from 2 Mio. € to 18 Mio. € for the cotton plantation and from 32 Mio. € to 145 Mio. € for the pecan plantation. Such a variability is not unexpected. Important for these two projects is the fact that they belong to the same factor characterized by the same growth rates and WACC values. That means that whatever values are chosen the relatively significant

difference in PVI for these projects would persist. Without doubt, comparing cotton with pecans is like comparing apples with pears. However, as the needed values are not available such a detailed analysis would require separate research.

4. Discussion

Until recently, the urban and regional planning process was split into two subprocesses that were working independently from each other: In a first step, the current situation was analyzed and evaluated using classical GIS software with its underlying databases of scientifically sound data. In the second step, planners draw their ideas of the future of a space relying on design software like 3D City Planner, Sketchup or Lumion. CityEngine from ESRI does bridge this gap, however, with the price of having highly skilled staff at hand, something that applies to the other software mentioned as well. In contrast, the Geodesign approach requires a platform that is so user-friendly that it can be utilized "live' e.g., during workshops. In addition, Geodesign besides using scientific criteria, encourages the inclusion of personal values for the evaluation of different scenarios because this is how the human brain works and makes its decisions.

Several comprehensive development plans for Harran District and its region have been written during the last ten years. One of the more recent ones, "Harran Management Plan" (Anadoku, 2016) is even a product of stakeholder consultations. Interestingly, all these plans share one important drawback: They become very vague if it comes to the question of where the mentioned (mega) projects should be located, and they lack the presentation of related maps. Naturally, this originates from the "Not in my backyard" thinking where a consensus of the "what: has been found however, this cannot be said on the "where: question.

This is exactly where PPGIS comes into play by offering tools for mediating the most critical step in regional and urban planning, which is spatial management. As has been shown in this research the used web-based software GDH enables all stakeholders to participate in the spatial planning process. For this, no knowledge of geomatics technologies is required. Still, it must be mentioned that the preparation of the needed data and the conduction of workshops cannot be realized without the involvement of both subject-matter and GIS experts. Although the workshop held during this project was a simulated one where all participants were either teachers or students of geomatics, agriculture and architecture, previous workshops organized by the authors of this paper proved the above made statement on prerequisites to be true.

The most crucial point whether development plans can be implemented or not is their economic feasibility. Parallel to building a spatial database, requirements for different development scenarios for the five sectors most important in our research area were defined. These requirements included data on costs, fees, subsidies, and revenues that would arise or could be earned for the major projects to be implemented in 30 years. This data covered costs in terms of current prices and the expected trend for the next 30 years. For the agricultural sector, planting and marketing of pecans seems to be an exceptionally suitable alternative to the dominating crop cotton because the world market has been in a big demand for pecans during the last years (Rafanan, 2021). Although it is hard to say if this trend will continue over 30 years, it could result in an NPV eight times higher than current practices.

However, we did not carry out an in-depth financial analysis. Rather, it was tried to feed the spatial analysis with economic data to enable all stakeholders to estimate the financial consequences of their suggested projects. For this, within GDH for all ten sectors costs per hectare were predefined. The weak point is that only one cost category can be used and no differentiation, e.g., between costs for squatter settlements or organized construction of new city quarters can be made. In this way, the sector sums up the costs for all the projects in each sector using an average cost factor. In addition, a special extension for NPV/DCF analysis was developed. Parameters like unit prices, WACC values or investment costs can easily be updated both for projects and whole sectors.

Some weak points of this financial analysis must be mentioned:

1) For one of the most important parameters impacting financial performance, the WACC factor, beta values must be defined for each sector. We had to rely on the values of the US market as they are usually only published for companies listed on the stock exchange. Due to the little concentrated structure of the agricultural and tourism sectors such data could not be found for Turkey.

2) Also, the exact time when the foreseen investments will be made will affect cash flows severely. Especially for the tourism and the urban development sectors, continuous growth has been expected and investments distributed accordingly. As the current pandemic has shown, such a growth could easily be disrupted.

3) For this kind of financial analysis, using a 30-year horizon adds additional risks. However, for ambitious scenarios like becoming a center of tourism shorter time horizons do not make much sense.

Besides these methodological considerations, distortion of the real picture that results from common cost/benefit analysis has been addressed. Projects cause costs and their economic benefits might not become apparent immediately or its consequences could only be measured by its social and environmental impact that under the current economic framework cannot easily be converted into financial numbers. Especially, the construction of a new satellite city under EA 2050 would come at a high price. If apartments can be sold as planned there would be a NPV of 97 million € after an initial investment of 313 million €. On the other side, doing business as usual and continuing with an urban development that is inappropriate for promoting development of the tourism sector will not be as cheap as it seems on the first glance: If people are forced to emigrate from Harran District due to missing job opportunities and will stay unemployed due to lacking skills costs that will have to be borne by the social

security system could be as high as 17,000,000 € for one year only. Naturally, these families would not be able to pay rent to stay in a legal building. Rather, they would erect another 'gecekondu' (meaning 'build overnight') at the edge of one of Turkey's megacities and thereby, increasing problems in these agglomerations. This urban-rural duality problem has been discussed in Turkey since decades (Erdem, 2016).

Spatial analysis with the GDH software reveals conflicts between competing projects within the same sector or different sectors instantly, especially between urban development and tourism. It is impossible to tolerate the encroachment of squatters onto the archaeological site of Harran and promote international tourism. However, if it is decided to implement EA 2050 that includes a careful urban development then, as examples from other cities like Carcassonne (France) and Alberobello (Italy), currently a partner city of Harran, prove, the tourism sector could outdo a cotton based agricultural sector by a factor of four. The NPV could be as high as 382 million €, which could be used for the further development of the region.

Political will is of utmost importance for the energy and transportation sectors too. For the light-rail project an up-front investment with public funding of 430 million € must be made. On the revenue side a negative NPV of 100 million € is expected and this only on the condition that half of the tourists would use it. These numbers would certainly change if indirect costs like CO2 emission reduction, traffic accidents minimization and reduced dependency on private cars had been included.

5. Conclusion

Worldwide, the importance of effective involvement of all stakeholders in regional and urban planning has been recognized. Tools like GDH have been developed and successfully used especially for the development of metropolitan municipalities for years. Based on GIS technology suitability maps are produced that form the basis for the most appropriate selection of projects in different sectors. More advanced systems include tools to make decisions according to a set of personal preferences or values and tools for negotiating between different interest groups. Then projects can be combined to create scenarios with different development options.

Although these systems are strong on the spatial side of planning their performance on the financial side can still be improved. For this research, a special extension for GDH for conducting NPV/DCF analysis was developed. Calculations of NPV and DCF required in-depth studies of the respective sectors to produce realistic numbers for investment costs and revenues for the planned projects.

Naturally, all financial numbers are subject to discussion and consequently, a PPGIS should support updating these numbers easily. While the approach described in this paper allows the instant change and recalculation of numbers for total investment costs, total revenues, and other parameters, changing the underlying components would still need a substantial amount of time. Therefore, more research is required on how to design appealing graphical user interfaces that facilitate the input of detailed data.

Government policy especially by means of subsidizing certain agricultural practices can change man-nude landscape totally. In the case of the EU, without subsidies for milk producing farmers the Black Forrest would return to an area completely covered by forest and tourism would no longer be an important source of income. Similarly, recent studies at the Department of Agricultural Economics at Harran University (oral communication) discovered that without the different subsidies including those for water and electricity paid to the farmers of Harran eventually this area would be turned into grazing lands again. As such subsidies have at least partially embedded in our financial analysis there is evidence that a redirection of these subsidies could help to convert Harran into a green garden. By this, both the agricultural and the tourism sector could undergo a more sustainable development – economically, socially, and environmentally.

Government policies will not change or if changed they will have insignificant effect without support from different interest groups at the local and regional level. Considering the current cultural background, it can be doubted whether any fundamental change will occur during at least one generation period in this least developed region of Turkey. There is no evidence that the brain drain from East to West (on a national and international scale) can be stopped soon. In its evaluation of the GAP project Benek (2009) concludes that even this mega project had only a modest impact on the regional structural problems: "It is seen that the works carried out within the scope of the GAP for a period of 30 years have not yet reached the desired level in terms of completing the projects within the targeted period and solving these structural problems..."

Author Contributions

Author1*:* Conceptualization, Writing-Original draft preparation, **Author2**: Data collection, Writing-Reviewing **Author3**: Writing-Reviewing, Editing, **Author4**: Software development

Statement of Conflicts of Interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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