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Advanced GIS (AGIS) journal aims to publish original research articles, review articles and technical notes in the field of Geographic Information Systems (GIS). GIS allows spatial analysis, modeling and visualization of the environment. Nowadays, GIS is actively used in many fields such as agriculture, monitoring of natural disasters, ecology, climate change, polar studies, transportation, defense, education, environment, forest, together with remote sensing. In this context, the AGIS journal focuses on studies in the field of GIS. There is no page limit for the articles to be sent to the AGIS journal.

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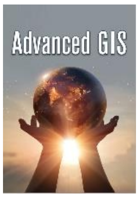

Geospatial intelligence (GeoINT) risk maps producing with geographic information systems (GIS) and creation of the 2D simulation model

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ABSTRACT

In today's world, many complex and hybrid warfare models are applied. Operational action plans play an active role in the implementation of these models. These plans use intelligence and spatial data as a base. At this point, we come across the concept of spatial intelligence, which brings together space and intelligence. Spatial intelligence; it is the analysis of data related to location, space and geography by bringing together data. In this study, the concept of intelligence and geospatial intelligence will be explained in detail. Afterwards, risk studies from the literature will be included. Finally, the modeling of risk in GIS environment and the production of risk maps will be discussed from a geospatial intelligence perspective. By transferring the steps of a model application with the aim of contributing to the literature of the study. The geospatial intelligence of the risk will be revealed with a 2 dimension three simulation model.

1. Introduction

Intelligence has been used effectively with different meanings by many civilizations from past to present. As an agent, in 5000 B.C. (BC), Egyptian King Tutmosis the 3rd determined his strategies in order to take the city of Jaffa; according to the intelligence reports of the agents he had previously sent to the country; he made his war plans. Thus, he captured the city of Jaffa with less cost (Acar, 2011; Odemis, 2014).

Today, fully institutionalized intelligence agencies have reached the national level institutional structure.

For domestic intelligence in the USA; Federal Bureau of Investigation (FBI), Central Intelligence Agency (CIA) for foreign intelligence, National Intelligence Organization (MIT) in our country, Federal Intelligence Service (BND) in Germany, Foreign Intelligence and Special Operations (MOSSAD) in Israel, Iran The Intelligence of the Islamic Republic of Iran (VAJA) is institutionalized with 7 different intelligence agencies in the British Kingdom (IA,2020).

The task of these intelligence agencies, which have been established in many countries and have survived to the present day, is to provide data flow to decision makers about current or potential risks, threats and opportunities. (Kucukbas, 2015).

The answer to the question of what is intelligence, in many languages; we see that it means different things. In English, 'intelligence', intelligence, mind, knowledge, 'reseignement' in French, (information), 'razvedka' in Russian, 'nachricten' in German, in Turkish intelligence is derived from the word news in Arabic (Ozkan, 2003; Oztoprak, 2011).

Intelligence, by definition, is a product information produced as a result of processing (extracting, interpreting) news (raw data) (Ilter, 2002, Oztoprak, 2011).

According to another definition, it is the whole of the data obtained from any open, semi-open or confidential source that can be accessed. These data are collected for the purpose of preventing damage to national or private policies. It is the information obtained as a result of classification, comparison, analysis and evaluation process according to importance and accuracy. (Ozdag, 2009).

Although the types of intelligence gathering are expressed in different ways, they are classified according to its purpose, level and method (Gundogar, 2007; Oztoprak, 2011).

In spatial/spatial intelligence with the recently developing spatial technologies; took its place in technical intelligence. With this intelligence method, it is

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important that satellite images and data from the field can be evaluated together.

Spatial intelligence is called Geospatial Intelligence (GeoINT) in English.

Geospatial intelligence is a discipline that contains three basic elements as shown in Figure 1. These are imagery, imagery intelligence and geospatial information.

The image includes any natural or man-made object; it is the recording of the existing range in the electromagnetic spectrum from satellite, aircraft or unmanned aerial platforms with remote sensing technologies.

Imagery intelligence is an auxiliary material that allows interpretations and analyses of geographic area with the help of images.

Geospatial information, on the other hand, is information that describes the spatial information and characteristics of a natural geographical area. This information is remote sensing, geodetic data and mapping products (GeoINT Basic Doctirine, 2006).

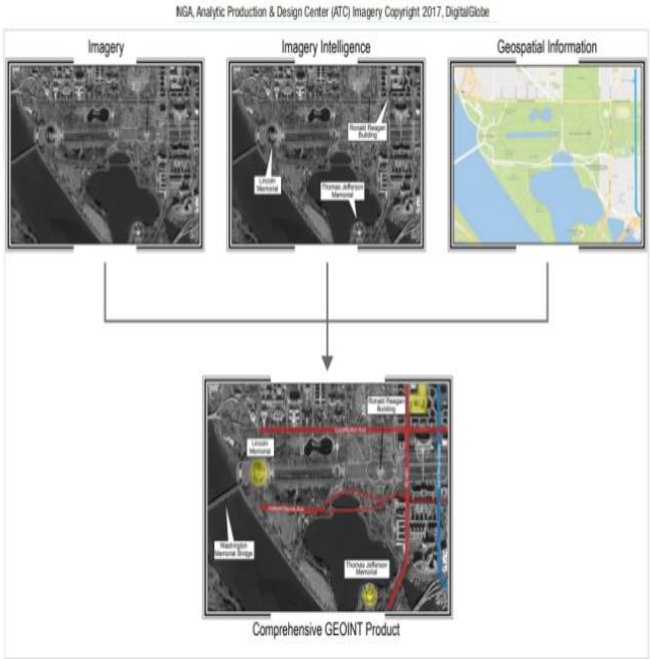

Figure 1. Geospatial Intelligence and the Three Elements (GeoINT Basic Doctirine, 2018)

When we look at the features of geospatial intelligence, geographic data set collection is performed using many different advanced sensors, shown in Figure 2. It brings together map data from many different sources. By providing three-dimensional (3D) and 4-dimensional (4D) thinking ability, it provides an intelligence opportunity that is used to determine the time and course of action in a dynamic and interactive way. (GeoINT Basic Doctirine, 2006).

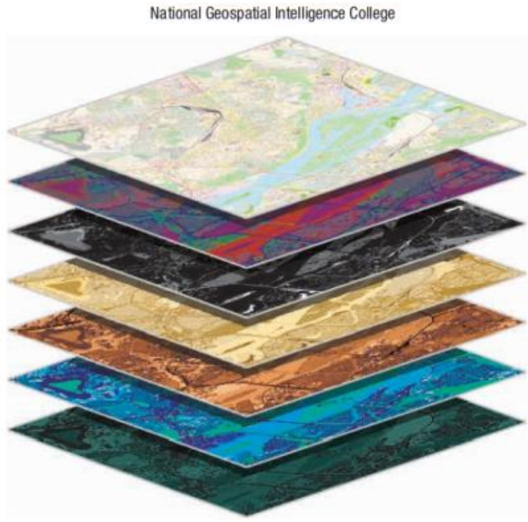

Figure 2. Geographic Datasets (GeoINT, 2018)

Geographical information systems (GIS) is one of the most effective tools that spatial intelligence uses in data analysis and interpretation, with its ability to combine many data sets, three-dimensional analysis and map production. GIS is an information system that provides results and outputs with the collection, storage, query and analysis possibilities of the data obtained through the observation of geographical information (Yomralioglu & Doner, 2000).

In the GIS environment, it is possible to bring together spatial data of different types and formats, to query and analyse separately or in an integrated way. With these capabilities, GIS acts as a decision-support system (Sarı ve Turk, 2020). The spatial analysis opportunity of GIS provides the opportunity to come up with stronger and sustainable solutions to problems by analysing spatial data under certain values and conditions (Onyıl & Yılmaz, 2020).

Among the wide usage areas of GIS, there are many areas such as earthquake, urban planning, urban transformation, production of epidemiological maps. (Erdogan, 2010; Yalcin & Sabah, 2017; Ledoux et al., 2021; Biljecki et al., 2021). In this context, GIS has become a must for hazard and risk analysis studies with its strong analysis capabilities. And it has been used in many risk and hazard analysis studies. (Udono & Sah, 2002; Fell et al., 2008; Yalcin & Sabah, 2018; Hepdeniz & Soyaslan, 2018; Sarı & Turk, 2020).

There are many GIS-based hazard and risk analysis studies in the literature. In the study carried out by Karakas et al. (2004), crime maps were produced with GIS. Within the scope of the study, it was stated that dangers and risks would be prevented by producing maps of time and places that pose risks, which were analyzed depending on different variables.

Yalcin &Sabah (2017)'s within the scope of the studies of industrial organizations in Edirne province and its districts that analyse the earthquake risk, earthquake risk analysis was carried out with the Analytical Hierarchy Process (AHP) method in the open source GIS software (QGIS) environment. As data sets; Active fault lines, geological formation status, earthquake epicentre points between 1908-2016 and locations of industrial establishments were used. As a result of the analysis, dangerous districts and industrial establishments were determined. Thematic maps were produced. As a result, it was stated that the earthquake hazard value of 59 industrial establishments in Enez and Keşan districts is high.

Aydar (2020)' s It is a study that includes the three-dimensional modeling of risky areas in hunting areas, in wildlife ecology, in a GIS environment. In the study, a survey was conducted by spatially correlating the wildlife data in Çanakkale province, Kalkım town pilot region. Obtained survey data were modelled via GIS with three-dimensional terrain model and satellite images; The maps were produced and the follow-up was given to the hunters and the personnel of the Provincial Directorate of National Parks to obtain information about the risky areas.

2. Method

In this study, within the scope of literature and developing technologies, against the risks and threats that may come in the operation area, for military base areas; It is aimed to provide a foresight for the future.

The study includes the operation area; modeling in the GIS environment and predicting the risks that may come, so that; to contribute to the preparation of complex action plans and the development of measures against the risks that may exist. In this study, an exemplary model was established for this purpose.

Afterwards, able to predict the data, the mode of operation of the enemy element and the risks, risks were revealed by producing risk maps in the GIS environment. Thus, whether there is a significant relationship between the behaviours of people and war elements and risk black points were tested on the sample model.

At this stage, the model consists of the steps of establishing the military base area and production of risk maps in the GIS environment. The flow diagram shown in Figure 3 has been designed for the process steps to be performed during the implementation phase.

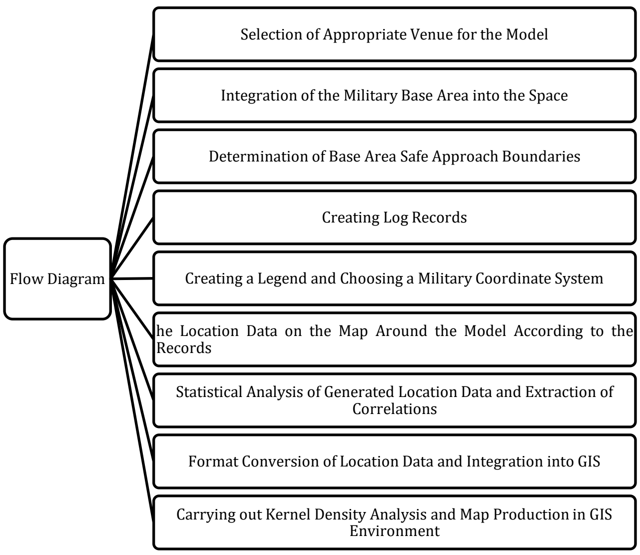

Figure 3. Flow Diagram

According to the flow chart, firstly, a suitable location was selected for the model military base area in Figure 4, then a 3D base area model was designed and the base area was placed in its position on the map for data generation, then; Ceride records of safe approach boundaries and daily living space mobility were produced by the author.

Figure 4. Selected for a military model and 3D base area

Then, a legend group was created according to the data records, and the data were processed around the model with the military coordinate system, according to the data records in Figure 5.

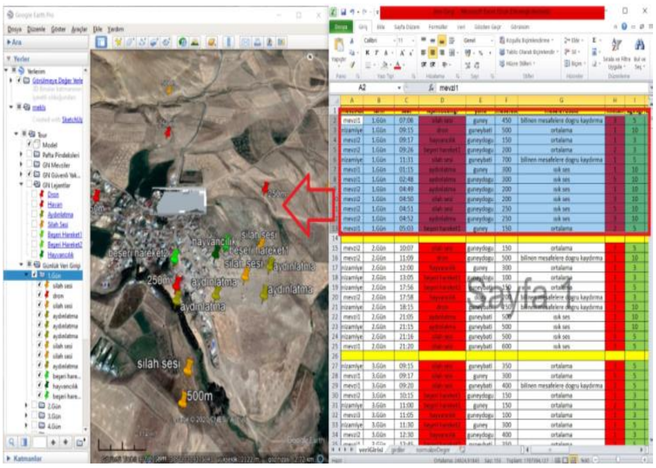

Figure 5. Data processed with Military Coordinate System

Finally, the transfer of the data to the GIS environment (ArcGIS Desktop) and the production of 72 risk analysis as shown in Figure 6.

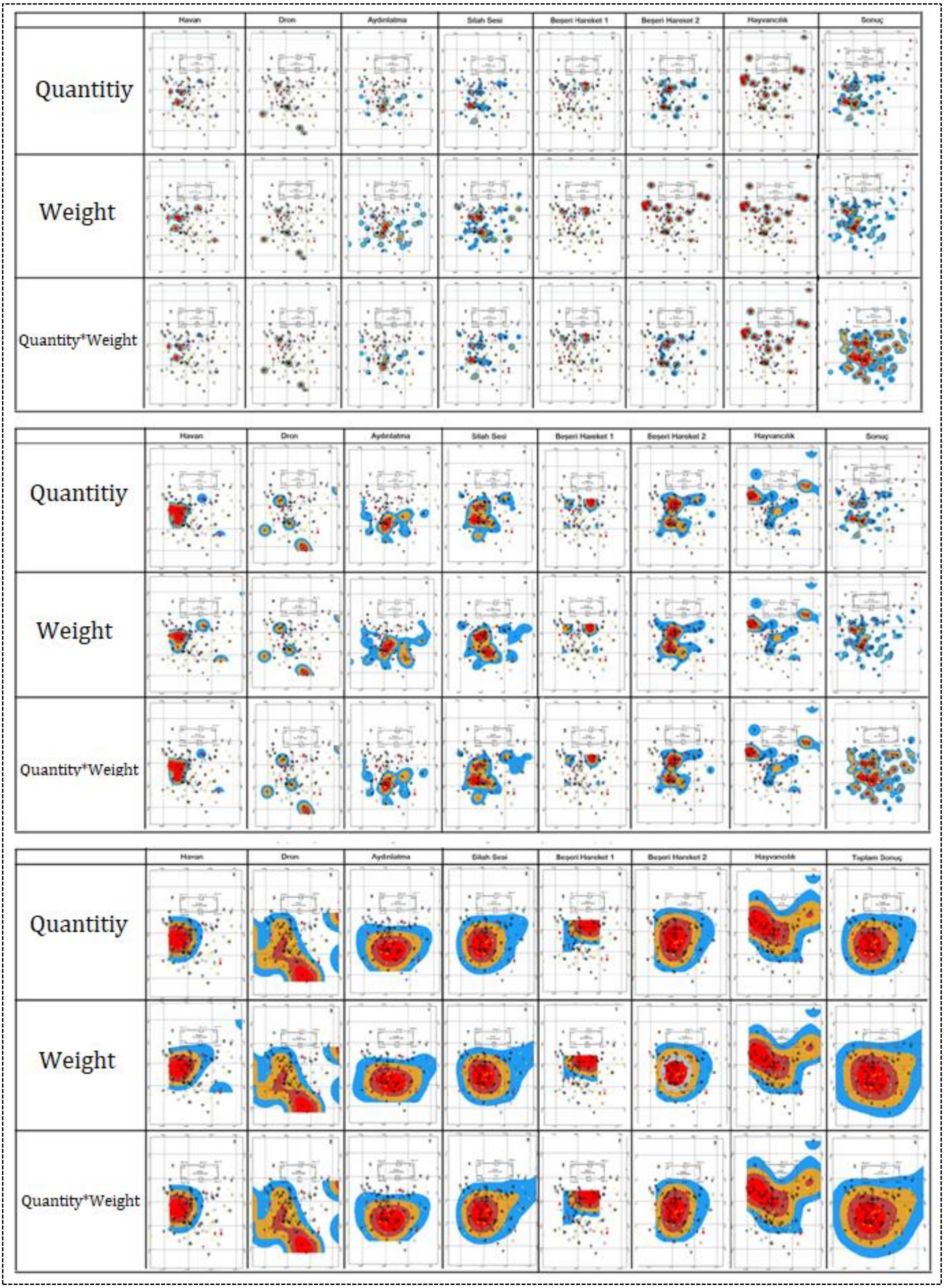

Figure 6. Risk analysis

3. Results

With the operation steps carried out within the scope of the study, a risk analysis was carried out with GIS in terms of spatial intelligence of the model military base region. The following findings were obtained with the process steps.

- It has been observed that the implementation phase, which starts with data acquisition, is practical in terms of modeling the reality.
- It has been found that the statistical analysis of the data is important for the analytical evaluation process of intelligence and will form the basis for the spatial analyses to be carried out in the process in Figure 7.

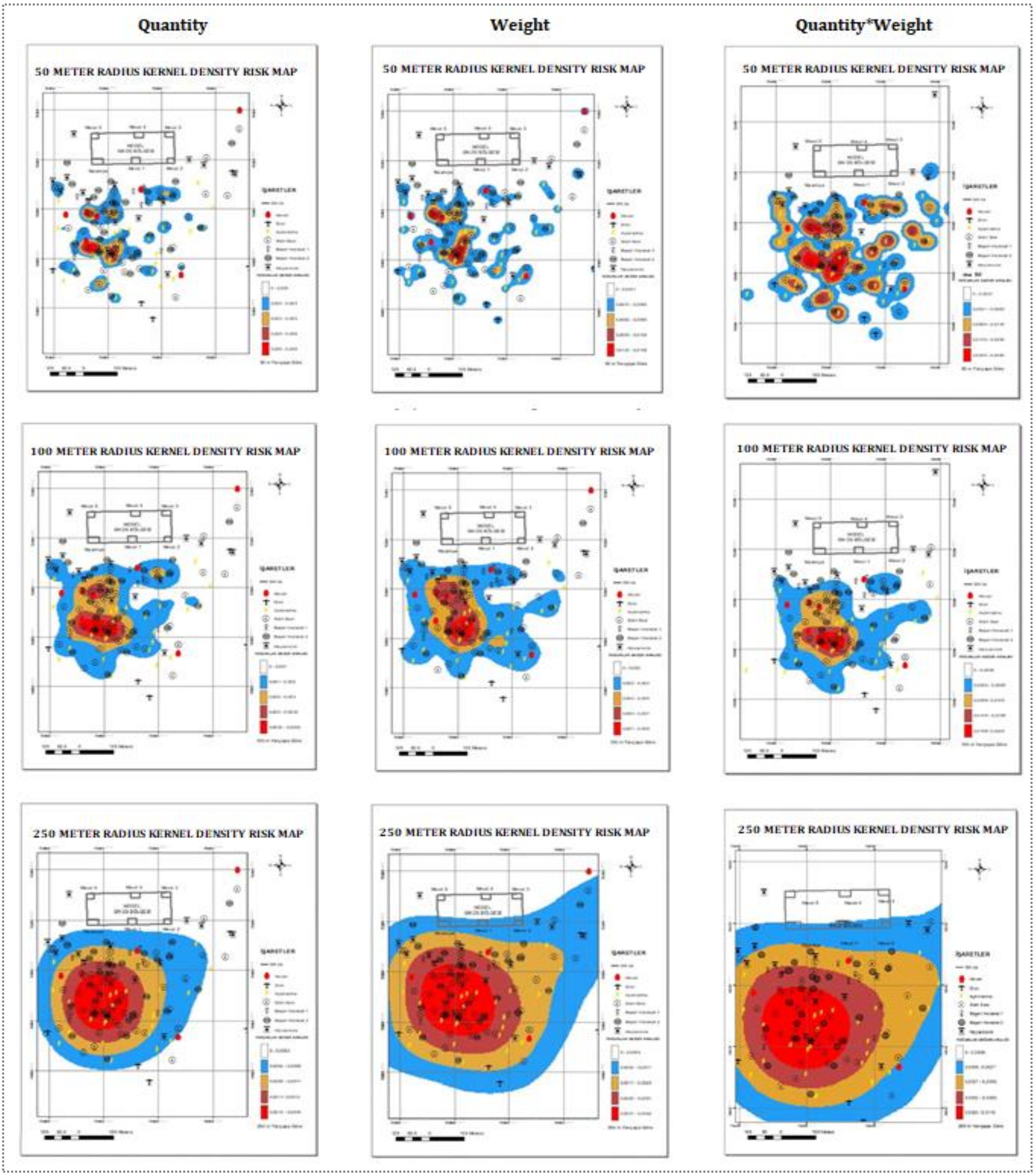

Figure 7. Risk analysis to risk maps

- The predictive modeling capability of the GIS for the future has been shown to be at a good level by testing the model on the military base area.
- It has been seen that the production of visual models of data through maps by using GIS can be used as an effective intelligence report source and will provide decision support for complex operation plans.
- In risk maps produced 2D simulation model with GIF simulation method. 2D simulation model to in Figure 8.

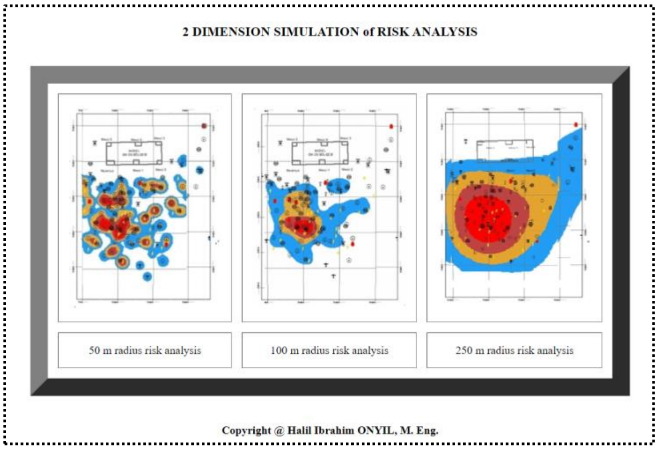

Figure 8. Creation of the 2D simulation model

Internet web site address of 2D simulation model: http://onyilharitamuhendislik.com/index6.html

4. Discussion

The success of this study is possible if the personnel in the military base area have been given intelligence and counter-intelligence (IKK) training, complete map information training, and speed, accuracy and analysis are carried out on time and delivered to the relevant units and institutions. In addition, a good temporal resolution can be gained with the 2.5 m resolution Gokturk-2 Satellite Images as a base satellite image for the studies.

In the coming years, time can be saved by transferring the data directly from the personnel in the position to the military operations center and from there to the joint operations centers with encrypted and user-friendly, easy, useful mobile software applications.

Finally, the analysis of the data and the production of the maps can be accelerated by developing a desktop and mobile application that will query and analyse the incoming data with user interfaces.

5. Conclusion

Within the scope of the study, a model military base area was established, enemy element data was produced considering the operation area and statistical analyses were carried out. Spatial data representation and estimation success of the operation area have been demonstrated.

Finally, a situation map was produced to show the current state of spatial data via GIS. Then, 72 different Kernel Density analyses were carried out according to the 7 legend values of the data, the determined weight values, the recorded amount values and the multiplication of the amount and weight values.

Thus, the risky areas around the military base areas located in the dangerous area within the operation area were presented as a visual product with maps.

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Author Contributions

The study was carried out by a single author.

Statement of Conflicts of Interest

The author declares no conflicts of interest.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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Automatic construction of a knowledge base for transport networks

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ABSTRACT

Abundant spatial transport data is accessible from governmental institutions or internet sources contributed from all over the world. This kind of data obtained from various sources exists in different structures and prevents interoperability. The aim of the research, in this paper, is to develop an ontology compatible with specifications of transport networks of Infrastructure for Spatial Information in the European Community (INSPIRE) and to obtain a knowledge base of transportation data from non-semantic data sources automatically. In the first stage, ontological classes and relations in the transport network are explained. Then, defining algorithms in three main phases, non-semantic spatial data is transformed into the ontological structure. Some ontological queries are implemented to retrieve information from a knowledge base that is produced because of the transformation algorithms. As a result of the study, the transportation datasets in the relational database have been successfully converted into a semantic data format. The functionality of the obtained knowledge base was validated with queries that allow semantic reasoning.

1. Introduction

Today transportation networks that are equipped with sensors and built with agents have been widely used in the various services of transportation systems. To obtain a proper intelligent transportation system that can derive logical conclusions and make decisions successfully, a transport network system needs to correspond with knowledge representation and ontology. To decide how to behave upon instant environmental inputs gathered from sensors, agents need an internal declarative body of knowledge (Arara & Laurini, 2005). Declarative languages are described with description logics (DLs) as a family of knowledge representation formalisms that are mainly characterized by constructors to build complex concepts and roles from atomic ones (Horrocks et al., 1999).

In the last two decades, ontology languages that are supported with DLs are the standards of knowledge representation. In order to state a semantic structure that computers are able to understand and communicate with each other, ontological domains should be composed of ontology languages (Gómez-Pérez & Corcho, 2002). Ontology languages define classes (concepts), properties (roles), data types, and individuals for a specific domain. Property characteristics such as transitive, symmetric, functional, and inverse specify a property to provide enhanced reasoning about the property (Smith et al., 2004). As explained in Horridge (2011), existential, universal, and cardinality restrictions determine individual ranges of a property in a domain. Today, ontology-based applications are particularly implemented with OWL-DL (Ontology Web Languages – Description Logic) based on the RDF (Resources Description Framework) as a language of semantic data (Horrocks et al., 2003).

Recently, many semantic approaches have also been proposed in Geographical Information Systems (GIS) so as to solve semantic problems which can be categorized into three main topics: The first topic is the geospatial data heterogeneity causing interoperability problems (Lutz, 2007; Yang et al., 2008; Zhang et al., 2010a). The second one is the information retrieval of the geospatial data over the internet providing geospatial search engines (Jones et al., 2004; Fu et al., 2005; Alazzawi et al., 2012). The third topic refers to the aspect of geospatial intelligence by retrieving implicit geospatial data from explicit one with knowledge reasoners which proposes context-awareness in GIS (Wang et al., 2004; Weissenberg et al., 2006; Akcay & Altan, 2011). All this scientific research apparently reveals the importance of the semantic knowledge base of geospatial data.

Transport networks as a kind of geometric network is also a considerable subject within the realm of

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semantic geospatial information sciences. In order to take advantage of the semantic data, in the transportation field, many approaches have been exploited by scientists (Fernandez & Ossowski, 2007; Dong et al., 2008; Gregor et al., 2012; Oliveira et al., 2013). A long-term project has been initiated, called Infrastructure for Spatial Information in the European Community (INSPIRE), to provide more collaboration and interoperability for geospatial data among European countries. The aim of the project is to define directives for spatial data infrastructure in various stages until 2019. In 2010, data specifications of Transport Networks were published by the INSPIRE Thematic Working Group (INSPIRE, 2010). The transport networks specifications explain features of all transport themes (road, rail, water, air, and cable) in Unified Modelling Language (UML) diagrams to develop intelligent systems such as location-based services (LBS), telematics and navigation services.

Geometric linestring objects as one of the fundamental GIS data, are the basic need of transport networks, can be obtained from various sources. Some of them are free GIS data web sites such as OpenStreetMap (OSM) (OpenStreetMap, 2012) and Tiger (Topologically Integrated Geographic Encoding and Referencing System) Product (U.S. Census Bureau, 2011). The format of the distributed data is shape file developed by ESRI as a common GIS format. Other data sources can also be accepted as aerial and satellite images. Automatic extraction methods might provide linear feature data so as to prepare a road network of an urban area (Park et al., 2002; Mena, 2003). The raw data of transport networks, however, need converting to knowledge representation formalism because of obstacles in using them semantically.

Despite the definition of a domain ontology being considered as a really difficult task, handling huge amounts of a non-semantic dataset as a part of the knowledge base (e.g., instances of the ontology) might also bring about complicated obstacles. Most of the researchers who are mentioned above are concerned about the meticulous construction of domain ontology and focus on inference abilities of the ontology. The appropriate presence of instances, however, is as important as the building of ontological concepts and properties to provide a complete knowledge base for semantic applications. Regarding domain ontology constraints, dataset mapping for instance, from a non-semantic database onto a knowledge base is an obligatory process. As datasets are traditionally stored and maintained in relational database management systems (RDBMS), geospatial datasets are handled in RDBMS, extended with spatial functions such as PostGIS, PostgreSQL, MySQL, and Oracle Spatial.

The purpose of this paper is to describe a transformation model that can achieve a knowledge base in compliance with INSPIRE data specification on transport networks from the geospatial transport dataset. As a result of the transformation, the large amount of spatial data available from many sources is obtained as INSPIRE-compliant ontological data in OWL-DL. The next sections of the paper are structured as follows. Section 2 presents an expanded review of the related research. The definition of the semantic road network model is proposed in section 3. To generate a semantic road network model the system architecture is explained in section 4 and then, section five describes transformation algorithms. The results of the implementation are given in section 6. Concluding remarks are discussed in section 7.

2. Related Works

Eight basic logical relations, also known as RCC8 (Region Connection Calculus) were defined by Randell et al. (1992) in order to express possible states of the two spatial objects in the space for spatial representation and reasoning. Eight relations of RCC were described as follows: equal, disconnected, externally connected, partial overlap, tangential proper part, non-tangential proper part, the inverse of tangential proper part, and inverse of the non-tangential proper part. Depending on the development of DLs which provides well-defined semantics, formal properties (complexity, decidability), reasoning algorithms, and implemented systems (reasoner engines), RCC8 was reconsidered by Wessel (2001) within the scope of DLs. These studies apparently enlightened some semantic geospatial research of today.

Transportation as a field of geospatial sciences is also influenced by advances in semantic applications in order to enable more intelligent and more interoperable systems. Data sharing is particularly discussed by the transportation community so as to establish interoperability between different data providers. About fifteen years ago, some semantic approaches in transportation were developed in order to overcome obstacles of data exchange and problems of knowledge representation (Bishr et al., 1999; Bishr & Kuhn, 2000).

Obitko & Marík (2005) explained transportation ontologies enabling communication between agents. The defined ontologies implement a multi-agent system with agent-based platforms for intelligence. The ontologies, however, do not concern comprehensive data interoperability. A semantic transit planning service proposed by Chen et al. (2008) is able to retrieve a transit trip plan using data aggregation and composition schemes. Houda et al. (2010) described ontologies for public transportation in Protege (2013). Public transportation ontologies presented trip plans as a result of some SWRL (Semantic Web Rule Language) rule-based queries. Oliveira et al. (2013) defined transportation ontology for user interface personalization. The study, however, considers only limited kinds of transport modes to solve the travel planning problem.

A new problem that appears after the building stage of transportation ontology is to obtain the knowledge base appropriately from non-semantic data sources. Zhang et al. (2008) developed an algorithm that is able to transform UML transportation data to OWL data form. The algorithm transformed UML packages, classes, attributes, and instances to OWL classes, relations, and individuals. Some issues, however, remained unsolved between UML and OWL. Furthermore, the more general transformation models lead to less comprehensive results for different data sources. Zhang et al. (2010a) and Zhang et al. (2010b) expressed semantic discovery and composition algorithms to eliminate semantic heterogeneity of transportation data.

Katsumi & Fox (2018) analyzed and compared the performance of various transportation ontologies. A transportation geoportal has been developed in accordance with the INSPIRE standard in the study, which deals with heterogeneous data (Gunay et al., 2014). Yu et al. (2017) developed a prediction method based on deep learning algorithms that require a long training time after transforming the traffic flow into static images. However, the development of the deep learning and knowledge base relationship put forward by Das et al. (2016) is another important problem that needs to be resolved. In the study of Ali et al. (2017), fuzzy logic ontologies and transportation properties were discussed. However, transferring non-semantic data to a knowledge base conforming to standards such as INSPIRE does not take place adequately in the literature (Table 1).

Table 1. Comparison among some related works

Study	The ability of semantic data construction	Compliance with a transport standardization
Gunay et al. (2014)	-	+
Das et al. (2016)	+	-
Yu et al. (2017)	+	-
The proposed study	+	+

As the importance of the transportation ontologies is understood from all related works mentioned above, the standardization problem of semantic transportation data and constructing a proper knowledge base, including instances and relations among them are remained unsolved. In this paper, a semantic model and an algorithm which implements the generation of a transportation knowledge base that is compatible with INSPIRE transportation network specifications is introduced.

3. Semantic Road Network Model

Generic Conceptual Model as a part of the data specification development framework of INSPIRE describes Generic Network Model (GNM) based on ISO 19148 (2012) (Geographical Information - Linear referencing) for network term definitions (INSPIRE, 2009). As an extension of the standardization, common transport elements application schema including road, rail, cable, water, and air transports are developed upon GNM (Figure 1). According to the application schema of road transport networks in INSPIRE 2010, features of RoadLinkSequence, RoadLink and RoadNode are defined as follows:

RoadLinkSequence: A linear spatial object composed of an ordered collection of road links, which represents a continuous path in a road network without any branches.

RoadLink: A linear spatial object that describes the geometry and connectivity of a road network between two points in the network.

RodeNode: A point spatial object that is used to either represent connectivity between two road links or to represent a significant spatial object such as a services station or roundabout.

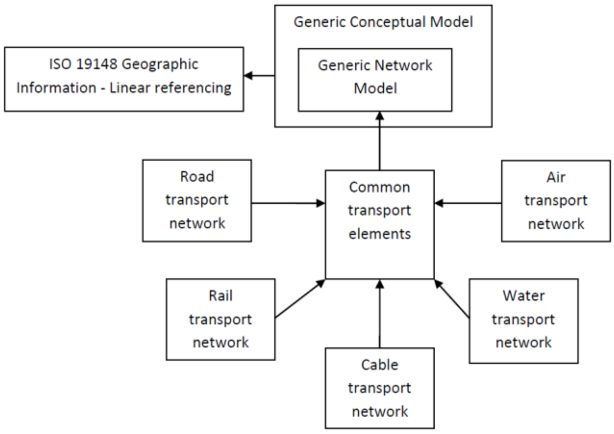

Figure 1. Inspire data specification on transport networks

As an example, Figure 2 depicts road link sequences, road links, and rode nodes in a road network. The figure includes 3 road link sequences, 7 road links, and 8 road nodes.

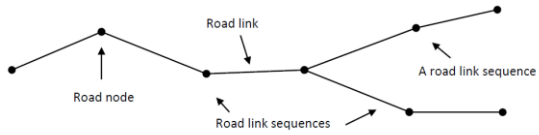

Figure 2. Road link sequence, road link, and road node

A semantic road network model (SRNM) consisting of classes, properties, and individuals, is built in conformity with INSPIRE road transport network application schema. The model has four classes (RoadNetwork, RoadLinkSequence, RoadLink, and RoadNode) and three object properties (contains, isPartOf, and isConnectedWith). The ontological object properties represent topological relations among the road classes (concepts). In Figure 3, in OWL syntax, three object properties and their types are defined. isConnectedWith property is a symmetric property while contains and isPartOf properties are transitive properties. Property types like symmetry or transitivity make contribution to a knowledge base so as to provide more inferences from implicit data. Figure 4 shows details of the ontological RoadLink class in road network in OWL syntax. According to the ontology, a road link is connected with other road links. Other written statements are that "RoadLink contains RoadNode" and "RoadLink isPartOf RoadLinkSequence".

```
<ObjectProperty rdf:about="&srnm;contains">
  <rdf:type rdf:resource="http://www.w3.org/owl#TransitiveProperty"/>
</ObjectProperty>
<ObjectProperty rdf:about="&srnm;isConnectedWith">
  <rdf:type rdf:resource="http://www.w3.org/owl#SymmetricProperty"/>
</ObjectProperty>
<ObjectProperty rdf:about="&srnm;isPartOf">
  <rdf:type rdf:resource="http://www.w3.org/owl#TransitiveProperty"/>
</ObjectProperty>
```

Figure 3. Object properties in semantic road networks

```
<Class rdf:about="&srnm;RoadLink">
  <equivalentClass>
     <Restriction>
        <onProperty rdf:resource="&srnm;isConnectedWith"/>
        <allValuesFrom rdf:resource="&srnm;RoadLink"/>
     </Restriction>
  </equivalentClass>
  <rdfs:subClassOf rdf:resource="&srnm;RoadNetwork"/>
  <rdfs:subClassOf>
     <Restriction>
        <onProperty rdf:resource="&srnm;contains"/>
        <allValuesFrom rdf:resource="&srnm;RoadNode"/>
     </Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
     <Restriction>
        <onProperty rdf:resource="&srnm;isPartOf"/>
        <someValuesFrom rdf:resource="&srnm;RoadLinkSequence"/>
     </Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
     <Restriction>
        <onProperty rdf:resource="&srnm;contains"/>
        <someValuesFrom rdf:resource="&srnm;RoadNode"/>
     </Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf>
     <Restriction>
        <onProperty rdf:resource="&srnm;isPartOf"/>
        <allValuesFrom rdf:resource="&srnm;RoadLinkSequence"/>
     </Restriction>
  </rdfs:subClassOf>
</Class>
```

Figure 4. RoadLink class and its relations between other road network classes

While defining classes with relations, there are two complementary matters in order to establish a robust semantic model. The first matter is that the class has an equivalent definition (defined class) or subclass definition (also known as a primitive class) by relation and its filler class (Horridge, 2011). In other words, a relation and its filler might be an upper (⊑) or an equivalent class (≡) of another class. The second matter is that if closure axiom is applied by a relation: Closure axiom is the combination of existential restriction (someValuesFrom ∃) and universal restrictions (allValuesFrom ∀). OWL inherits Open World Assumption (OWA) from Description Logics so as not to accept one reality as wrong without an explicit definition. OWA is a feature of reasoning that distinguishes OWL from relational databases. Table 2 expresses the ontological relations among classes using existential and universal restrictions under a given condition. In the table, (⊑) indicates necessary conditions, while (≡) represents necessary and sufficient condition.

Table 2. Conditions and definitions of relations with their filler classes. Used abbreviations: F.: Filler, Seq: Sequence, connWith: connected With

Class	Class	Relation	F. Class
RoadLink	⊑	∀contains	RoadNode
RoadLink	⊑	∃contains	RoadNode
RoadLinkSeq	⊑	∃contains	RoadNode
RoadLinkSeq	≡	∃contains	RoadLink
RoadNode	≡	∃isPartOf	RoadLink
RoadNode	⊑	∃isPartOf	RoadLinkSeq
RoadLink	⊑	∀isPartOf	RoadLinkSeq
RoadLink	⊑	∃isPartOf	RoadLinkSeq
RoadLink	≡	∀connWith	RoadLink
RoadLinkSeq	≡	∀connWith	RoadLinkSeq

4. Generation of Semantic Road Network

Transformation architecture has been designed in order to convert a non-semantic spatial data of a road network into a road network knowledge base. The algorithms in the architecture aim at obtaining road links, road link sequences and road nodes as individuals from a geospatial database as seen in Figure 5. The proposed system produces a knowledge base as an ontology file in OWL syntax upon SRNM. Before the transformation process, definitions of class taxonomy and relations (object properties) are written to the OWL file, as explained in section 3. The system input is geospatial data of the road network that is composed of a set of linestring representing the geometry of the roads.

As shown in Figure 5, a spatial database in the architecture includes three tables: a link table, a sequence table, and a node table. The link table stores geospatial attributes of the road network which is derived from the file of the network (input file), the table is then used to populate instances of RoadLink. The sequence table and node table are non-spatial tables that support determining and defining instances of RoadNode and RoadLinkSequence.

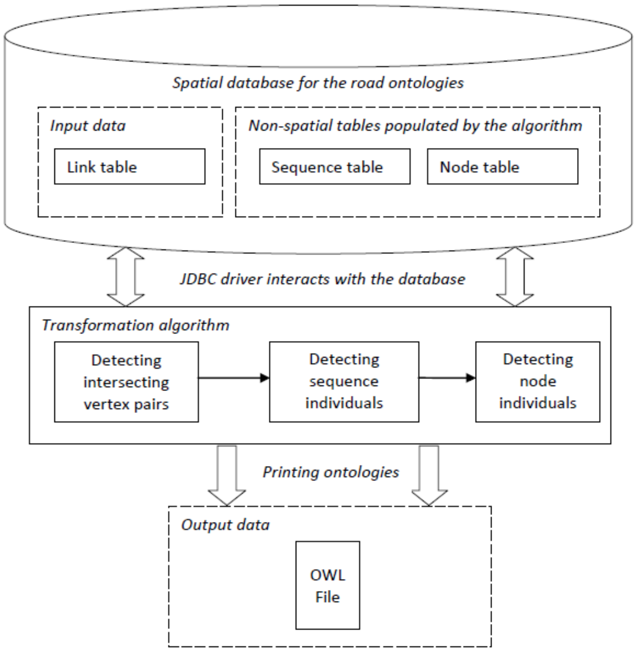

Figure 5. System architecture to produce road ontology

The center of the system which manages the transformation is the algorithm. The algorithm, including three main phases, is implemented in the Java programming language code. The phases 1 and 2 retrieve instances of the RoadLinkSequence in the database while the third phase defines instances of the RoadNode for the knowledge base. Interactions between the algorithm and PostgreSQL/PostGIS spatial database are provided by a Java Data Base Connectivity (JDBC) driver. In the next section, a transformation algorithm that retrieves instances will be elaborated on further.

A produced OWL file of the knowledge base includes all road network data semantically except object coordinates. The coordinate information of the spatial objects in the network could be possibly added to the ontology file as a data property. It is however intentionally excluded because a semantic reasoner is not as powerful as a spatial database concerning calculations for a huge amount of numerical data. Instead, a proposed semantic model infers implicit conclusions using topological relations.

5. Transformation Algorithms

A transformation algorithm produces a knowledge base of transportation network considering INSPIRE standards using topological relations of a geometrically featured spatial database. The aim of the algorithm is to retrieve instances of the classes (RoadNode, RoadLink and RoadLinkSequence) and relations among these instances using query functions of spatial database, such as intersection, equality, and touch. Each row of the link table represents a road link as defined in the INSPIRE road transport network. In the algorithm, the most obstructive tasks are to retrieve the node instances and sequence instances. The road link sequences, and road nodes are determined, using spatial features of the link table. The algorithm processes are as stated in the flow diagram in Figure 6.

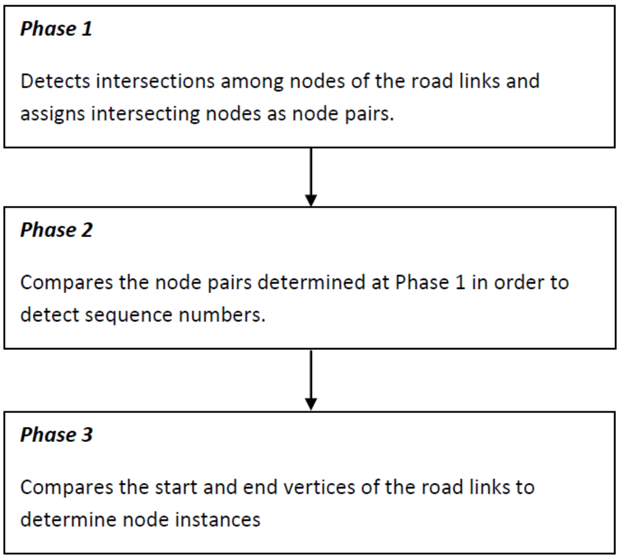

Figure 6. Process flow of the algorithm

5.1. Phase I

Phase I detects intersections between the start and end nodes of the road links and assigns intersecting nodes as a pair. It is assumed that n indicates the number of road links in the link table, v_i^s and v_i^e represents the start and end node of the i^{th} road link, v_j^s and v_j^e represent the start and end node of the j^{th} road link and $P = \{p_1, p_2, .., p_m\}$ is the set of the node intersection pairs. Between two road links, one of the four intersection possibilities is (v_i^s, v_j^s) , (v_i^s, v_j^e), (v_i^e, v_j^s), (v_i^e, v_j^e), therefore, might occur as a unique member of set P.

The algorithm is mainly based on the relations between the start and end points of the links. As shown in pseudo algorithm I, set P which has individuals of pairs among the start and end points of the links is obtained Figure 7. Intersection pairs (individuals of set P) are assigned into the n1 and n2 columns of the sequence table. After the algorithm of phase, I is implemented, multiple intersections (pairs), more than two at one point among road links indicate a junction point for different road link sequences, are deleted from columns n1, n2.

To clarify the transformation algorithm, the road network in the Figure 8 will be elaborated as an example. Figure 8 shows a simple road network composed of 31 road links. Figure 9a shows intersection pairs while Figure 9b depicts a sequence table for road links of the road network at Figure 8. To prevent complexity, labels of vertices and labels of some road links and are omitted in Figure 8. For instance, the start point of the 21th road link and the end point of the 28th road link form an intersection pair (v_{21}^s, v_{28}^e) as seen at the last row of the table in the Figure 9a. After phase I is applied and multiple intersections are eliminated, the table is obtained as shown in Figure 9a. Furthermore, the start point of the road link 28 intersects with road link 9 and road link 12 (v_9^e, v_{28}^s), (v_{12}^s, v_{28}^s) are determined as junction point and deleted from Table 9a. Multiple intersections are deleted from the table as they are not part of the same sequence.

```
defineSetP                              Determine set S as the intersection pairs of vertices.
    P = {∅}                             Assume that set S is an empty set.
    FOR i ← 1 to n DO                   For loop compares start points of road links.
        FOR j ← 1 to n DO               For loop compares start points of road links.
            IF (i! = j) THEN            If statement determine different road links to compare.
                IF (v_i^s ∩ v_j^s) THEN If statement determine intersection of start points of road links.
                    P = P ∪ {v_i^s, v_j^s}  Intersection pair is assigned to set P as an element.
                ENDIF                   End of if statement.
                IF (v_i^s ∩ v_j^e) THEN If statement seek for intersection between start and end points.
                    P = P ∪ {v_i^s, v_j^e}  Intersection pair is assigned to set P as an element.
                ENDIF                   End of if statement.
                IF (v_i^e ∩ v_j^s) THEN If statement seek for intersection between start and end points.
                    P = P ∪ {v_i^e, v_j^s}  Intersection pair is assigned to set P as an element.
                ENDIF                   End of if statement.
                IF (v_i^e ∩ v_j^e) THEN If statement determine intersection of end points of road links.
                    P = P ∪ {v_i^e, v_j^e}  Intersection pair is assigned to set P as an element.
                ENDIF                   End of if statement.
            ENDIF                       End of if statement.
        ENDFOR                          End of for loop.
    ENDFOR                              End of for loop.
```

Figure 7. Pseudo code of Phase I

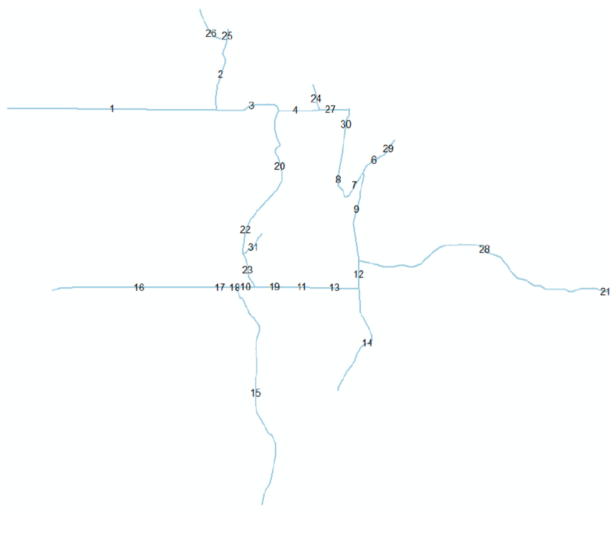

Figure 8. A road network with their road link numbers

n1	n2	seqno
4e	5s	1
6e	29s	2
7s	8s	3
8e	30e	3
27e	30s	3
11s	13e	4
11e	19s	4
16e	17s	5
17e	18s	5
20s	22e	6
21s	28e	7

(11 rows)

gid	sequence
1	8
2	9
3	10
4	1
5	1
6	2
7	3
8	3
9	11
10	12
11	4
12	13
13	4
14	14
15	15
16	5
17	5
18	5
19	4
20	6
21	7
22	6
23	16
24	17
25	18
26	19
27	3
28	7
29	2
30	3
31	20

(31 rows)

Figure 9 Intersection pairs between road links start and end vertices in link sequence table (9a is the left figure); final sequence numbers in road link table (9b is the right figure)

5.2. Phase II

Phase II determines road link sequences from vertex pairs (Figure 10). The algorithm of phase II assigns a unique number to each sequence that includes more than one road link (Figure 9b). Sequence numbers which are therefore made of only one road link are assigned later. Sequence numbers of each road link are inserted into the "seqno" column of the sequence table (Figure 9a).

Let's assume that m indicates the number of individuals in the set P. S represents the sequence numbers of pairs while s_{pi} indicates the sequence number of the pair p_i. Seqno is a variable that assigns sequence numbers of the pairs. In the given example, $P = \{p_1 = (v_4^e, v_5^s), p_2 = (v_6^e, v_{29}^s) \dots (v_{21}^s, v_{28}^e)\}$ and $m = 11$ (the total number of the row at figure 9a).

When phase II is implemented, $s_{p1} = 1, s_{p2} = 2, s_{p3} = 3, s_{p4} = 3, s_{p5} = 3, s_{p6} = 4, s_{p7} = 4, s_{p8} = 5, s_{p9} = 5, s_{p10} = 6$ and $s_{p11} = 7$ are obtained, as seen in Figure 9a. Then, in Figure 9b, link table is extended with the "sequence" column in order to assign a final sequence number to each road link object. Additional to the sequences are explained in Figure 9a, other sequences, including only one road link, are determined uniquely. Sequence assignment of one road link sequence is not indicated in phase II due to its excessive code length.

5.3. Phase III

Phase III compares the start and end vertices of the road links to determine node instances (Figure 11). In the algorithm, set R is defined as an empty set. Then, the start and end points of the road links are compared with the element of set R and, a point is assigned to set R once, if they have not been assigned before to set R as an element. Consequently, each element of set R represents a node instance in the knowledge base.

Let's assume that l indicates the number of nodes in the node table, while R is the set of nodes and r is an individual of set R: $R = \{r_1, r_2, \dots, r_l\}$.

```
defineSetS(s_pi)                           Determine set S as the sequence instances of the network.
  seqno = 1                                Assign 1 to seqno variable.
  s_p1 = seqno                             Assign 1 to the pair 1 as sequence number.
    FOR i ← 1 to m DO                      For loop compares pairs i and j to find sequence numbers.
    FOR j ← (i + 1) to m DO                For loop compares pairs i and j to find sequence numbers.
      IF(p_i ∩ p_j && s_pi! = 0 && s_pj == 0) THEN
        s_pj = s_pi                        If statement assign sequence number of pair i to j.
      ENDIF                                End of if statement.
      IF(p_i ∩ p_j && s_pi == 0 && s_pj! = 0) THEN
        s_pi = s_pj                        If statement assign sequence number of pair j to i.
      ENDIF                                End of if statement.
      IF(p_i ∩ p_j && s_pi == 0 && s_pj == 0) THEN
        seqno ++                           Increase the seqno value.
        s_pi = s_pj = seqno                If statement assign new sequence number to pair i and j.
      ENDIF                                End of if statement.
    ENDFOR                                 End of for loop.
    ENDFOR                                 End of for loop.
```

Figure 10. Pseudo code of Phase II

```
defineSetR(r_l)                            Determine set R as the node instances of the network.
    R = {∅}                                Assume that set R is an empty set.
    R = R ∪ v_1^s                          Add start point of link 1 as the first element of set R.
    FOR i ← 1 to n DO                      For loops compare start points of road links with current
        FOR j ← 1 to l DO                  elements of set R.
          IF(v_i^s ∩ r_j = ∅) THEN         Add the start point as new element of the set R,
            R = R ∪ v_i^s                  if they are different
          ENDIF                            End of if statement.
        ENDFOR                             End of for loop.
    ENDFOR                                 End of for loop.
    FOR i ← 1 to n DO                      For loops compare end points of road links with current
        FOR j ← 1 to l DO                  elements of set R.
          IF(v_i^e ∩ r_j = ∅) THEN         Add the start point as new element of the set R,
            R = R ∪ v_i^e                  if they are different.
          ENDIF                            End of if statement.
        ENDFOR                             End of for loop.
    ENDFOR                                 End of for loop.
```

Figure 11. Pseudo code of Phase III

6. Results

Ontologies enable complex queries which retrieve implicit information from explicit data. Infinite query combinations can be derived from an ontology domain. For the given example above, two different complex queries and their results are explained in this section in order to clarify what ontologies are able to do. Queries, in the example, are written in the nRQL (New RacerPro Query Language), (Haarslev et al., 2007). nRQL is a query standard compatible with RacerPro. RacerPro stands for Renamed ABox and Concept Expression Reasoner Professional and is a reasoner engine for semantic web languages.

Individuals are determined with the algorithms that is explained in section 5. An individual definition also includes ontological relations with other individuals. The similar algorithms based on topological relations are used to define mentioned relations among individuals. However further algorithms about the relations are omitted here due to repeated versions of explained algorithms and possibility of an overlong paper. As a result of the implementation of the algorithm, 31 RoadLink individuals, 31 RoadNode individuals and 20 RoadLinkSequence individuals with numerous relations are obtained for the sample data set presented above. In excerpts from the knowledge base, individuals of

RoadLink, RodeNode and RoadLinkSequence are illustrated in figure 12, 13, and 14, respectively.

```
<NamedIndividual rdf:about="&srnm;RoadLink3">
  <rdf:type rdf:resource="&srnm;RoadLink"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLink1"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLink2"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLink4"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLink20"/>
  <srnm:contains rdf:resource="&srnm;RoadNode1"/>
  <srnm:contains rdf:resource="&srnm;RoadNode2"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLinkSequence10"/>
</NamedIndividual>
```

Figure 12. Individual of RoadLink3 and its relations

```
<NamedIndividual rdf:about="&srnm;RoadNode1">
  <rdf:type rdf:resource="&srnm;RoadNode"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLink1"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLink2"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLink3"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLinkSequence8"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLinkSequence9"/>
  <srnm:isPartOf rdf:resource="&srnm;RoadLinkSequence10"/>
</NamedIndividual>
```

Figure 13. Individual of RoadNode1 and its relations

```
<NamedIndividual rdf:about="&srnm;RoadLinkSequence4">
  <rdf:type rdf:resource="&srnm;RoadLinkSequence"/>
  <srnm:contains rdf:resource="&srnm;RoadLink11"/>
  <srnm:contains rdf:resource="&srnm;RoadLink13"/>
  <srnm:contains rdf:resource="&srnm;RoadLink19"/>
  <srnm:contains rdf:resource="&srnm;RoadNode8"/>
  <srnm:contains rdf:resource="&srnm;RoadNode9"/>
  <srnm:contains rdf:resource="&srnm;RoadNode15"/>
  <srnm:contains rdf:resource="&srnm;RoadNode9"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLinkSequence12"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLinkSequence13"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLinkSequence14"/>
  <srnm:isConnectedWith rdf:resource="&srnm;RoadLinkSequence16"/>
</NamedIndividual>
```

Figure 14. Individual of RoadLinkSequence4 and its relations

As seen in figure 12, individual RoadLink3 is topologically connected with road links 1, 2,4 and 20; contains road nodes 1 and 2; and is part of road link sequence 10. Figure 13 explains individual RoadNode1. According to the definition of RoadNode1 in the knowledge base, RodeNode1 is part of road links 1, 2, 3 and; road link sequences 8, 9 and 10. Figure 14 is about individual RoadLinkSequence4 that contains road links 11, 13, 19; road nodes 8, 9, 15, 19; and is connected with road link sequences 12, 13, 14, 16.

Query 1 retrieves road link individuals which have at least one neighbour road link each belonging to the same road link sequence at each of its sides. Table 3 defines query 1. Variables in NQRL are prefixed with "?". Injective variables are prefixed with "$?". In the queries of the example, all variables are assigned as injective variables. Haarslev et al., (2007), an injective variable is explained as a variable which can only be bound to an ABox individual that is not already bound to another injective - the mapping from variables to ABox individuals is thus injective. Concepts and relations in the query must be written with its URL (Uniform Resource Locater) as defined in the owl file. For the owl file and the queries presented in this work, URL is defined as "http://www.semanticweb.org/ontologies/2013/02/srnm.owl#". In order to abbreviate and simplify the query sentence, prefix URLs are omitted. Result of query 1 yields road links individuals 8, 11, 17, 30 as stated in Table 4 and Figure 15.

Query 2 asks for any individuals at intersection of three neighboring road link sequences as explained in Table 5. Reasoning engine answer to the query 2 is stated in Table 6 (see Figure 16 for a graphic version of the answer of query 2).

Table 3. Definition of query 1

Line	Parts of query 1 statement	Definition
1	(retrieve ($?y)	Variable will be retrieved after execution
2	(and	Logical operator connects sentences from line 3 to 11
3	($?x RoadLink)	Variable for road link individuals
4	($?y RoadLink)	Variable for road link individuals
5	($?z RoadLink)	Variable for road link individuals
6	($?x $?y isConnectedWith)	Variable pairs for connecting road link individuals
7	($?y $?z isConnectedWith)	Variable pairs for connecting road link individuals
8	($?t RoadLinkSequence)	Variable for road link sequences
9	($?x $?t isPartOf)	Variable pairs for road link individual covered by sequence
10	($?y $?t isPartOf)	Variable pairs for road link individual covered by sequence
11	($?z $?t isPartOf))	Variable pairs for road link individual covered by sequence

Table 4. Answer of query 1

Line	Search variable	Retrieved instances
1	((|$?y|	RoadLink8)
2	(|$?y|	RoadLink11)
3	(|$?y|	RoadLink17)
4	(|$?y|	RoadLink30))

Table 5. Definition of query 2

Line	Parts of query 2 statement	Definition
1	(retrieve ($?n)	Variable will be retrieved after execution
2	(and	Logical operator connects sentences from line 3 to 11
3	($?x RoadLinkSequence)	Variable for road link sequence individuals
4	($?y RoadLinkSequence)	Variable for road link sequence individuals
5	($?z RoadLinkSequence)	Variable for road link sequence individuals
6	($?x $?y isConnectedWith)	Variable pairs for connecting road link sequence individuals
7	($?y $?z isConnectedWith)	Variable pairs for connecting road link sequence individuals
8	($?x $?z isConnectedWith)	Variable pairs for connecting road link sequence individuals
9	($?n $?x isPartOf)	Variable pairs for individuals covered by sequence
10	($?n $?y isPartOf)	Variable pairs for individuals covered by sequence
11	($?n $?z isPartOf))	Variable pairs for individuals covered by sequence

Table 6. Answer of query 2

Line	Search variable	Retrieved instances
1	((|$?n|	RoadNode1)
2	(|$?n|	RoadLink2)
3	(|$?n|	RoadLink4)
4	(|$?n|	RoadLink6)
5	(|$?n|	RoadLink7)
6	(|$?n|	RoadLink9)
7	(|$?n|	RoadLink18)
8	(|$?n|	RoadLink19)
9	(|$?n|	RoadLink20)
10	(|$?n|	RoadLink22))

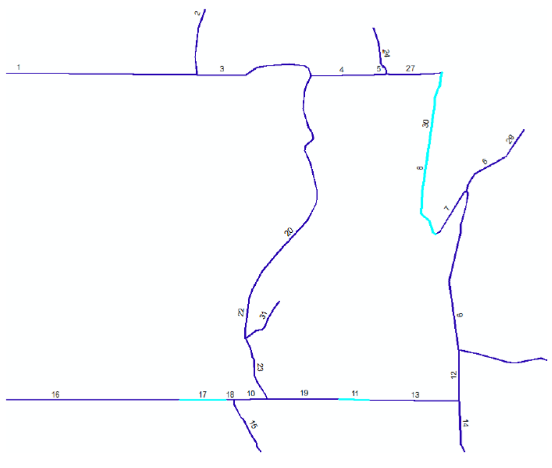

Figure 15. Graphic result of query 1

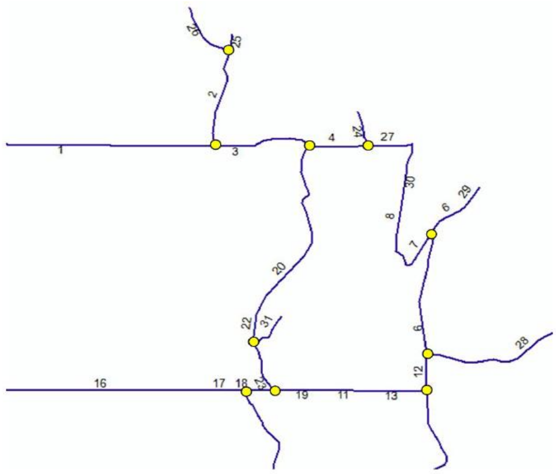

Figure 16. Graphic result of query 2

7. Conclusion

Semantic approaches applied on either transportation systems, or any other systems deal with some geospatial obstacles. The main obstacle is to set up an appropriate ontological structure enabling reasoning as much as possible. For example, two different semantic transportation systems having the same explicit information but built up with different ontological taxonomy and object properties (two knowledge bases with different expressive power) might have different performances to produce implicit information as a result of ontological queries and reasoning. Capability of obtaining implicit information from a knowledge base indicates its computational complexity. Setting up an ideal ontology having enough expressive power for transportation is still an open question.

Another bottleneck is to obey international data standards while building an expressive knowledge base. Standards are supportive documents to establish semantic data structure from non-semantic one. To be obliged to codes of standards, however, make it difficult to obtain a fully expressive knowledge base.

Semantic data is superior to a traditional geospatial data built in a database regarding query speed and capacity. In knowledge bases, answer time is shorter than queries of relational database management systems (RDBMS), as queries are based on sentence syntax in semantic engines. Data in RDBMS spatial databases is stored as numerical codes, therefore the performance of geometric functions is slower when considering huge amounts of data. This drawback of spatial databases has tried to be overcome with indexing. Actually, converting semantic data might be called as a kind of indexing. Furthermore, acquired semantic data as a result of transformation will be ready for agent-based smart applications and provide advantages of interoperability.

Due to the wide scope of INSPIRE data specifications on a transport network, a more comprehensive transformation should be discussed than the subjects handled in this paper. Transportation algorithms therefore should be a research subject, including various data types, such as, road speed limit, traffic flow direction and traffic signs. Especially, this kind of information is an inevitable requirement for applications of smart navigation systems and location-based services.

Author Contributions

The study was carried out by a single author.

Statement of Conflicts of Interest

The author declares no conflicts of interest.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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Researching the use of infrastructure in land management

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ABSTRACT

Since soil is the cornerstone of human life, it has an important place in both individual and social life. Therefore, the soil needs management for its continuity, that is, its sustainability. Infrastructure is the general name of the facilities such as transportation, electricity, internet, drinking water, sewerage, road and landscape for a building or an area where people live, work or reside. Infrastructure work and facilities are of great importance for the quality of life and economy. In this study, the use of infrastructure in land management was investigated. The importance and contributions of land management were researched and presented during the infrastructure project design and implementation studies. Various problems can be encountered while making infrastructure projects. If we reduce these problems to 3; we can reduce the passage of highways as passing from the state waterworks structure and passing from the private property. In the study, although we talk about how these 3 problems can be solved in general, it has also been tried to find solutions to other problems and problems. The technical specifications of Iller Bank, which has become professional in infrastructure in our country and have carried out many studies with its technical team, have been used as material.

1. Introduction

If we define the land in general before defining the land management; Land: the piece of land integrated with everything on earth (mountain, plain, building, stream, lake, etc.).

Land management, on the other hand, is the management needed to benefit from natural resources with high efficiency and to prepare sustainable development policies in rural and urban areas, both environmentally and economically (Çete & Yomralıoğlu, 2009; Demirel & Gür, 2008). İşiler (2012) explains the importance of land management as follows: Today, it has become mandatory to manage land, which is seen as a social scarce resource, in line with sustainable development goals. Effective and beneficial land policies are needed for the management of land, which is a consumable and finite resource (Yomralıoğlu, 2021). Ownership, value and land use information provided by land administration systems is needed for the development of land policies. In other words, while sound land information enables the development of appropriate land policies, well-formed land policies support effective land management and administration (Çelik & Çoruhlu, 2021; Ünel et al. 2020). The land is a source of wealth for individuals as well as an economic value for countries and even an important part of social and political life for societies.

Infrastructure is the general name of the facilities such as transportation, electricity, internet, drinking water, sewerage, road and landscape for a building or an area where people live, work or reside. Infrastructure work and facilities are of great importance for the quality of life and economy (Şahin & Yakar, 2021; Ulvi et al., 2020; Doğan & Yakar, 2017; Yakar & Mırdan, 2017).

In an article in the Zoning Law No. 3194, the importance of infrastructure is mentioned as follows; Buildings cannot be licensed unless the owners of the parcels on both sides of the infrastructure, which has been completely constructed by the relevant person or institutions in more than one residential area, with the permission of the relevant management, receive a fee (price) corresponding to their own parcels.

In this study, infrastructure works carried out in different areas were examined in general terms. Various suggestions were presented by mentioning the technical specifications and issues to be followed in infrastructure works, the land problems experienced during the project and implementation phases and the solution methods that can be brought to these problems.

2. Material and Method

Study, planning and feasibility study principles are the first work to be done on the land where the project is planned and is the cornerstone of land management. According to the study, planning and feasibility study

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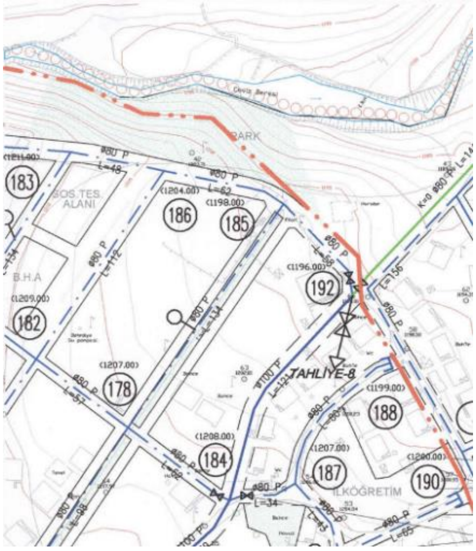
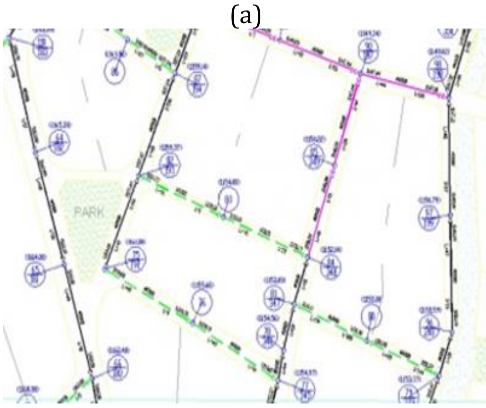
principles, the land management is done and the project stage is started. The titles of survey, planning and feasibility study principles related to land management are presented below (Figure 1).



(a)



(b)

Figure 1. (a, b) Drinking water network line designed on the zoning plan

a-) Administrative, Geographical and Historical Condition of the Land. The name of the working area in the field, the name of the district and province to which it is administratively affiliated, the closest transportation network or networks (air, land and railway) in the study area or study area; geographically, the winter-summer transportation conditions, general topography, vegetation, climate and precipitation intensities together with the dates; Historically, historical development and special situations are indicated.

b-) Socio-Economic and Cultural Situation. All events and phenomena that can be evaluated economically as well as a society can be called socioeconomic. The economic characteristics of the people living in the study area, development activities, commercial areas, the status of entertainment centres, health, education, transportation status, sports, tourism, industrial status, the status of military units and other organizations, livelihoods, urbanization, market areas, parking areas, state of agriculture and animal husbandry.

c-) Condition of Existing Facilities. The status of the existing facilities in the project area is analysed and detailed in the report. In which year and by which administration the construction of the existing facility was made; It should give information about the pipe types used in the application, the type of bedding-liner material and the trench depths. If there is no active facility on the land and a new infrastructure work is planned, when the application (construction) will take place, the water requirement and population amounts are specified as parameters required for the project.

d-) Map and Zoning Plan Situations. Map and zoning plan situations are perhaps the most important topic of survey, planning and feasibility studies in terms of land management. Whether the study area is within the zoning boundaries or not, if it is within the zoning boundaries, the regulation and approval dates are obtained from the relevant municipality and added to the report. At the same time, the zoning plan projection year and population are included in the report. With the above information in the report, only the current situation can be studied. The following information is added to the report so that future studies can be carried out; whether there are revised or additional plans, the status of the development areas in the zoning plan and whether they meet the needs.

2.1. Some Important details from technical specifications

Obtaining maps of transmission line and main pipe routes

It is prepared on a 1/2.000 or 1/1.000 scale.

It includes 75m right and left of the transmission line. However, this figure 2 may vary considering the topographic structure of the study area. The elevations of some and polygon points are determined by round-trip levelling and these elevations are recorded on the map (Iller Bank, 2021a).

For an optimal numerical model, it is necessary to take detailed points from the field. For 1/2.000 scale, there should be a minimum of 40 points on 10.000 m^2, and for 1/1.000 scale, there should be 80 points on 10.000 m^2 (Iller Bank, 2021b).

All-natural and human elements (highway, railway, river, stream, building, land, etc.) on the transmission line route are specified and the areas where it cuts the route are determined.

If there is a garden on the land, whether it is planted or cultivated or not, and if there is information on the land vegetation, areas with features such as swamps and landslides are shown on the maps.

Detail points are shown with their elevations and numbers on the map. The comma of the jeans represents the detail point. The texts are written perpendicular to the north on the map. North direction and scale are shown on maps.

Continuity of the map is ensured by making a bellows so that the top point is outside the paper, in order to draw the map on paper of certain sizes. After examining different solutions on these drawings, the approved route is applied to the field.

For the application process, the polygons and detail points previously established on the land are used. The polygon line is not selected coincident with the pipeline route. On the route, the source, maslak, stream crossing, highway crossing, horizontal drilling, pumping centres, air chimney, etc. in the project. productions are marked.

2.2. The application is made according to the following principles

It can be applied by using satellite or terrestrial photogrammetric methods for the application process.

The application process is applied depending on the ground control points.

Application sketch and plans; It is prepared for the implementation of projects and plans on the ground.

Length measurement accuracy is ± (5 mm + 5 ppm) and better theodolites are used.

Electronic theodolites with an angle measurement accuracy of ±10CC (3'') and better are used.

The distance between the theodolite and two measurements cannot exceed 500m.

Geodetic GNSS receivers are used in the application with GNSS. The largest base length cannot exceed 5000 m.

In these application processes, it is done according to the application method with coordinates.

While the application is being made, it is measured and calculated in 10CC thinness with electronic devices that can directly measure 100CC at angles, and the lengths are measured and calculated in centimetres thin with an electronic distance meter. However, previously checked and approved steel tape measures are used in the application process of lengths up to 20 meters.

2.3. Ditch width and depth

There are certain standards for trench widths, depths and distances from the top of the pipe to the ground level in the transmission line and network lines. While determining these standards, traffic load calculation due to the pressure to be applied to the pipe, frost and heat event due to the adverse conditions of the seasons, etc. It is determined to be at least 1.00 m from the top of the pipe to the ground level, taking into account other effects.

However, where the altitude is more than 2000m, the depth from the top of the pipe to the ground should be 1.25m. The trench width is determined as 40 cm + pipe diameter, usually 20 cm to the right and left of the pipe, in addition to the pipe diameter.

Under normal conditions, the values given above are valid, but these values can be reduced by considering the water drainage difficulties in areas where groundwater is too close to the surface or too much, in cases where filling cannot be done on the ground in urban applications. In other words, the depth from the top of the pipe to the ground can go below 1.00 m. If there is a possibility to fill on the ground after the transmission line is laid, the pipeline is placed above the groundwater level, in this case parallel passages are considered so that the filling does not interfere with the surface waters.

(a)

(b)

Figure 2. Ditch digging

Under normal conditions, the values given above are valid, but these values can be reduced by considering the water drainage difficulties in areas where groundwater is too close to the surface or too much, in cases where filling cannot be done on the ground in urban applications. In other words, the depth from the top of the pipe to the ground can go below 1.00 m. If there is a possibility to fill on the ground after the transmission line is laid, the pipeline is placed above the groundwater level, in this case parallel passages are considered so that the filling does not interfere with the surface waters.

When the drinking water transmission line coincides with other network lines, it can be crossed in parallel or by planning lower or upper crossings. However, in cases where there is overlap or convergence with the sewerage zones, intersection point projects are prepared. Trench excavation depth can be increased or decreased when necessary by taking special precautions and measures against wastewater.

Drinking water transmission line; It cannot approach the sewer, storm water and waste water pipes less than 3.00 m horizontally. Drinking water transmission or network line at intersections; It should be 30,00 cm higher than the sewer, rain water and waste water pipes and their chimneys should not intersect.

2.4. Bedding and covering

Before the trench excavation work is completed and the pipes are laid in the transmission lines, crushed stone (gravel) is poured into the trench, which we call bedding, in a way that is usually 15 cm (Figure 3). After the pipes are laid on the bedding, crushed stone is poured, which is generally called 30 cm lining. Importance of bedding and covering; after the line is completed, it distributes the pressure that will come from anything on it by spreading. In this way, the pipes will not be damaged. Of course, bedding and coverage amount and crushed stone size (0.32, 0.70, 0.22 mm) vary according to the location and structure of the land.

Figure 3. Bedding and covering

2.5. Study area

The study area of İller Bank Gaziantep Regional Directorate was chosen as the study area. It covers 5 provinces including Gaziantep, Kahramanmaraş, Şanlıurfa, Adıyaman and Kilis with all their districts and villages. Although 4 of the provinces are from the South-eastern Anatolia Region, only Kahramanmaraş is in the Mediterranean region. This field of study was chosen because I am a Gaziantep Iller Bank personnel and have a good command of the region, projects and practices.

2.6. Data

The physical data in the study were obtained from the Gaziantep Regional Directorate of Iller Bank, and the technical principles to be followed in the field were obtained from the Iller Bank Technical Specifications. These technical specifications;

-Technical specifications for the preparation of studies, feasibility and projects in drinking water facilities

-Technical specification for the preparation of architectural projects

-Water intake structures project technical specification

- Soil survey technical specification

These specifications refer to the principles and rules that must be followed in infrastructure applications.

2.7. Method

While looking for solutions to the problems, literature research, the regulations of the institutions were examined and interviews were made with the technical experts related to the subject. The method is preferred because there are many problems and factors in the field, so there is more than one solution method, so more than one method has been preferred.

3. Results

As can be seen in Figure 4, the transmission line passes through the citizen's land. There are different options for a solution here;

Solution 1: The consent of the land owner can be obtained.

Solution 2: Expropriation can be applied to the part of the land that can pass through the transmission line.

Solution 3: Since the transmission line passes 1m above the earth's surface, the transmission line can be laid with the verbal consent of the land owner without any payment or transaction.

Figure 4. Personal possession

Here, the 3rd solution is applied. Because, after all, this transmission line is a drinking water transmission line and drinking water goes to its own compatriots or relatives. Here, the person used his conscience and human values and gave verbal consent.

As can be seen in Figure 5, the transmission line passes through the citizen's land. There are different options for solution here;

Solution 1: The consent of the land owner can be obtained.

Solution 2: Expropriation can be applied to the part of the land that can pass through the transmission line.

Solution 3: Since the transmission line passes 1m above the earth's surface, the transmission line can be laid without any payment or transaction by obtaining the verbal consent of the land owner.

As in the previous example, the 3rd solution is applied here as well. The reason is the same as the previous example. As seen in Figure 8, the transmission line passes through the dry creek bed owned by the State Hydraulic Works (DSI). Here, there are no different options for the solution as in the previous examples, there is only one solution; Permission can be obtained by correspondence between institutions (the institution that tendered the project (İlbank) – DSI).

If this area was not a dry creek bed but a stream rehabilitated by DSI, DSI regulation certainly does not allow the expropriation limit of the creek improvement area to be approached more than 6 meters.

Figure 5. General directorate of state hydraulic works land (Dry stream bed)

After the necessary approvals were obtained from DSI by making inter-institutional correspondence, the project started to be implemented. As can be seen in Figure 6, the ownership of the transmission line passes through the General Directorate of Highways (KGM). The solution here is similar to Figure 5 and is as follows; Permission can be obtained by correspondence between institutions [the institution that tendered the project (İlbank) - KGM]. However, when we look at the KGM regulation, it in no way brings it closer to the expropriation limit of highways than 6 meters. It only allows horizontal transfers in the forms and methods within the regulation.

Figure 6. Crossing the Highways

As seen in Figure 6, the transmission line did not go directly under the highway. From a certain part of the line (S416), it was crossed to the other side of the highway with horizontal drilling and the line proceeded on the right of the road. In order for the transmission line to continue from where it was in the project again, horizontal drilling was carried out at S419 in accordance with the KGM horizontal drilling procedures and principles, and the other side of the highway was passed. This is how the problem is solved here.

4. Conclusion

In this study, some problematic examples of infrastructure work such as transmission lines and sewer lines in the field are given and discussed. In the findings part, the problems with the citizen, DSI and KGM are presented with pictures in Figure 6-7-8 and Figure 9.

Three different solutions have been proposed for the problems with the citizens in the field. These solutions are as follows;

Solution 1: The consent of the landowner can be obtained.

Solution 2: Expropriation can be applied to the part of the land that can pass through the transmission line.

Solution 3: Since the transmission line passes 1m above the earth's surface, the transmission line can be laid without any payment or transaction by obtaining the verbal consent of the landowner.

During the project works, a plan-quote is prepared 75 m to the right and 75 m to the left of the route where the line will be built, and all public institutions and organizations are informed about the project work with a distributed cover letter, and the public institutions and organizations that have ownership on the route notify this property in written and digital form; The project is revised through these data. If there is still a public institution or establishment property on the route after all these procedures, the following solution method is applied. There is only one solution to the problems with official institutions in the field, and that is as follows;

The problem can be solved by correspondence between institutions. Here, the parties of correspondence are the institution that tendered the project and the institution holding the property on the route where the line passes.

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Author Contributions

The study was carried out by a single author.

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The author declares no conflicts of interest.

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Research and publication ethics were complied with in the study.

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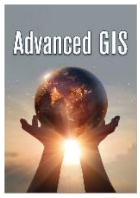

Regression analysis and use of artificial neural networks in housing valuation forecasting: case example of Güvenevler neighbourhood in Mersin

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ABSTRACT

Real estate valuation is the process of determining the value of the real estate made to evaluate the factors related to the properties, use and benefits of the real estate. Along with the developing technologies, real estate valuation processes move to modern evaluation methods. In this study, forecasting models were developed for sale price using Regression and Artificial Neural Networks (ANN) methods by using residential data for sale located Güvenevler neighbourhood in Mersin. In this study, the effects of some physical properties such as age, location, number of rooms, balcony condition, number of bathrooms, gross area, facade of the houses in Güvenevler neighbourhood on sales pricing were investigated. In this study in order to make the data more meaningful, Min –Max normalization was performed and regression and ANN modelling was done. SPSS program was used for regression analysis and Matlab program was used for ANN method. With the developed forecasting model, it is aimed to control the price tracking of the old residential district Güvenevler neighbourhood. According to the results of the study, while the rate of explaining the total variation of the independent variables in the housing prices is 92% in the regression analysis, in the network created with ANN, the ratio of independent variables to explain dependent variables is 93%. Both methods are successful because they give results within certain limits.

1. Introduction

From the ancient times when civilizations emerged to the present, the use of the land and the structures on it (immovable) has kept its importance and has become increasingly popular (Doğan & Yakar, 2018; Ulvi et al., 2020). The right of disposal of the right holder on the immovable has been defined, and the purchase and sale transactions have been placed on a legal basis. At this point, the value of the real estate must be determined to carry out the purchase and sale transaction (Hacıköylü, 2016; Yakar & Mırdan, 2017). This process is expressed as real estate valuation; It is known that buyer-seller satisfaction is important in terms of being a guide for comparable properties (Tekeli, 1996; Arıcı et al., 2002; Aksoy et al., 2010; Pirounakıs, 2013).

Real estate valuation; is the process of determining the value of the real estate by using valid and reliable methods, taking into account all the features of real estate, environmental conditions of use, and current economic indicators (Aydın Esmeray, 1996; Bayraktar, 2019). One of the basic parameters for the correct determination of the real estate valuation is the region where the real estate is located. However, all inputs (information and documents) must be provided completely, and this information must be interpreted and evaluated correctly (Demirarslan, 2005).

In addition, for the valuation to be reasonable, the real estate valuation must be at a level to meet different objectives. These targets are;

- Trading valuation
- Taxation
- Expropriation
- Bank mortgage and lending
- Land privatization.

There are various traditional methods for real estate valuation. Nowadays, with the development of technology, new techniques have been added to the existing methods. Evaluated among the traditional methods; comparison, income and cost methods are still the main methods used for real estate valuation today (Yılmaz, 2019; Özen & Şişman, 2019).

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The use of statistical science for the valuation of real estate and the acceptable level of results showed that Statistical Methods can be used in this process (Bulut Nas, 2011; Bozdağ & Ertunç, 2020). Occurring in these two methods; Some problems, such as the different price evaluations made by different experts for real estate, led to the development of alternative valuation methods. These methods are defined as Modern Valuation Methods. Real estate valuation methods are expressed by Yalpır (2007) as in Table 1.

Table 1. Real estate valuation methods

Traditional Valuation Methods	Statistical Methods	Modern Valuation Methods
Comparison	Nominal	Artificial Neural
Income	Multiple	Networks
Cost	Regression	Fuzzy Logic
	Hedonic	Spatial Analysis

It is known that there are problems in the valuation of real estate in Turkey as in the rest of the world (Clayton et al., 2009; Wyman et al., 2011; Uğur et al., 2012; Yayar & Gül, 2014; Erdem, 2017; Demirel et al., 2018; Ünel & Yalpır, 2019; Ünel et al., 2020; Yalpır & Ünel, 2022). Problems such as deficiencies in the legislation or the outdated legislation over time, the differences between the real estate value and the real market conditions cause problems in the real estate valuation. It is known that the vehicles, which are in demand as real estate in Turkey and whose sales transactions are carried out, are residences. As interest in the housing market increases, an increase in value is observed. As the population of Turkey increases, the number of houses built is increasing. For this reason, the demand and supply balance in the market cannot be maintained (Ellibeş & Görmüş, 2018). Therefore, it is the tool with the most problems.

It is important to determine the real estate valuation with objective, accurate and reliable sources. The real estate value, the current value, which emerges as a result of the valuation process, plays a major role in the country's taxation as well as in the purchase and sale of real estate (Işıklı, 2019). The fact that Artificial Neural Networks (ANN) has become a popular method has led to its use in real estate valuation. (Öncül, 2008; Yılmaz et al., 2018; Ulvi & Özkan, 2019; Tabar, 2020). ANN, inspired by the features of the human brain; are computer systems that develop abilities such as deriving, discovering and creating new information through learning, automatically without any help. Realization of these capabilities is very difficult with traditional programming methods. Therefore, ANN can be defined as a computer science developed for the analysis of big data (Öztemel, 2003). ANN is applied for data analysis using similar functional properties of the human brain. Such as learning, optimization, classification, analysis, generalization, association, estimation (Öztemel, 2003).

There are price disparities between homes in the same area that have similar features. When there are price variations, homeowners normally determine the pricing of their homes by comparing them to previous sales and then listing them for sale. Estimating the price of a home is a complicated procedure that involves evaluating several variables. The ANN approach may be used to estimate prices thanks to advances in technology.

The real estate valuation studies carried out using the ANN method in the literature are given below.

Khalafallah (2008) analysed real estate sales by performing ANN forecasting modelling for real estates with eight inputs and one output. As input data in the study; time, average interest rate, percent change in sales volume compared to the previous year, change in house price compared to the previous year, average days the house was on the market, inventory volume, inventory month supply; As the output data, factors such as the ratio of the house between the sales and sales prices (PrDf) were used.

In another study conducted with ANN by Ulvi & Özkan (2019); A model research was carried out to determine the real estate values. In this study, models were created by applying ANN and Fuzzy Logic methods to the collected data. It was determined that the calculation made with ANN gave results closer to the correlation value and it was stated that ANN was a more suitable method.

In the study of Kang et al. (2020), estimation models were developed with artificial intelligence and statistical methods by using the prices of the houses sold by the auction method in Seoul. In their study, they used 33 independent variables, including auction sales prices as dependent variables, 7 auction data, 14 physical data and 12 economic data. As a result of the analysis, they found that the auction valuation price was the most effective variable.

The goal of this research is to develop an estimating system for evaluating houses for sale in Mersin's Güvenevler District by employing the ANN approach.

2. Material and Method

2.1. Study area

In this study, the test area was determined as Güvenevler neighbourhood in Yenişehir district of Mersin province (Figure 1). It was named Güvenevler neighbourhood, which was previously connected to the Bahçelievler District, then separated due to the rapid increase in the population with the establishment of Forum mall. Dumlupınar street, 20. street, 1. street, 18. street, Huseyin Okan Merzeci Boulevard (2nd Ring Road) and Gazi Mustafa Kemal Boulevard pass through it. It is the biggest neighbourhood of Yenişehir district. It is the 6th largest neighbourhood in the city centre. Forum mall covers 13% of the neighbourhood. The neighbourhood is located in the middle of the city centre. The distance of the neighbourhood to the sea varies between 350 meters and 1.83 km.

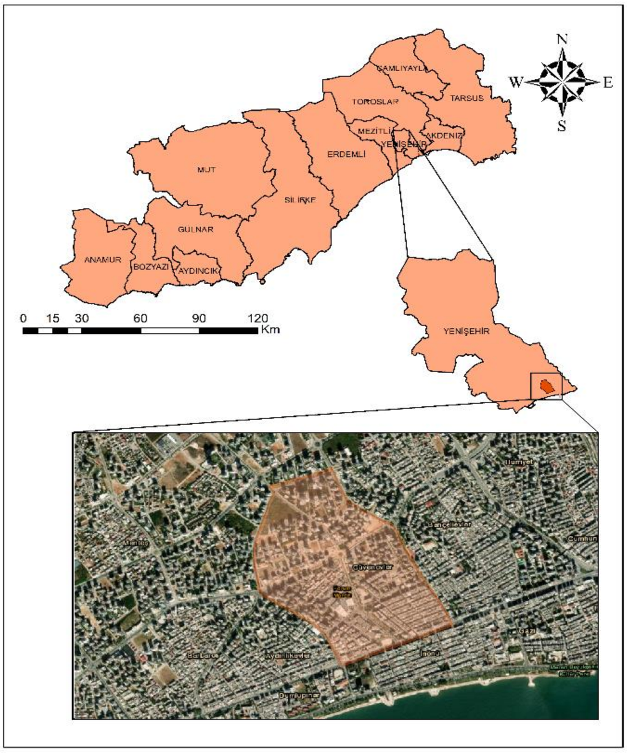

Figure 1. Güvenevler neighbourhood location map

The reason for choosing Güvenevler neighbourhood is that it is close to the biggest shopping centre in the province and the prices are suitable data for the model in housing purchases and sales.

2.2. Data used

The housing data selected in the study consists of 70 houses that were put up for sale from online market platforms in February and March 2020.

Table 2. Variables used in the study

The dependent variable	Independent variables	Usage
	Land area	Square meters
	Gross area	Square meters
	Location of the floor	Lower-Middle-Upper floor
	Number of rooms	1+1,2+1,3+1 and above
Price of the house (F)	Building Age	0-30 years old
	Building floors	1 and above
	Floor location	Ground and above
	Number of facades	1, 2, 3, 4
	Heating Type	Natural Gas and Other
	Number of balconies	1,2,3,4
	Number of bathrooms	1 and above
	Site status	
	Pool status	
	Elevation status	
	Security status	
	Generator status	Yes or No
	Parking status	
	Social area status	
	Concierge status	

Attributes of residences; plot area, gross area, location, number of rooms, building age, number of floors, floor, number of facades, type of heating, number of balconies, number of bathrooms, site, pool, elevator, security, generator, parking lot, social area, concierge and price consist of variables. Table 2 shows the dependent and independent variables of the study.

2.3. Methods used

Within the scope of the study, by applying Min-Max normalization methods to the raw data set, SPSS multiple regression analysis and using Matlab 2018 program, feed-forward backpropagation algorithm from artificial neural network models, and trainlm (Levenberg-Marquardt backpropagation) algorithm as training algorithm, price prediction was made.

2.3.1. Normalization methods

In multiple regression analysis and artificial neural networks, the data can be converted into a better form and used by applying normalization methods to the inputs and outputs. There are different techniques in normalization operations. In the study, raw data were normalized using Min-Max and Z-score rules.

Z-score normalization rule:

$$X' = \frac{X_i - u_i}{\sigma_{\text{i}}} \quad (1)$$

In this equation;

X' = normalized data

$X_i =$ Input value

u_i = Average the input set

σ_i =standard deviation of the input set

represents.

The Min-Max method linearly normalizes the data. The Min-Max rule is:

$$X' = \frac{X_i - X_{min}}{X_{\max} - X_{min}} \quad (2)$$

In this equation;

X' = normalized data

$X_i =$ Input value

X_{min} = The smallest number in the input set

X_{max} = The smallest number in the input set

represents.

2.3.1 Multiple linear regression analysis

Multiple regression analysis, which is one of the mass real estate valuation methods, is the most widely used statistical analysis method in the literature. Multiple Linear Regression (CLR) Analysis, on the other hand, is used for model validation of methods such as artificial neural networks, fuzzy logic, genetic algorithms in mass real estate valuation (Yeşim & Tokgöz, 2021; Tabar et al., 2021). In multivariate regression analysis, the independent variables simultaneously try to explain the change in the dependent variable.

Mathematical model of CLR analysis:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} + u_i \qquad (3)$$

Y_i = Dependent variable (value of real estate)
$X_{i1}, X_{i2}, \dots, X_{ik}$ =Its arguments (shares, area, TAKS, KAKS, number of floors, ... etc.)
u_i =Distortion or error term
β_0 = constant coefficient
$\beta_1, \beta_2, \dots, \beta_k$ = variable coefficients
represents.

2.3.2. Artificial neural networks (ANN)

The basic unit of artificial neural networks is the processing element or the artificial neural, which is called a neuron. As seen in Figure 2, the inputs are indicated by the X symbol. After each of these inputs is multiplied by the weight W, the threshold value is added to the Q, and the output f(x) is found by processing with the event function to generate the result. The learning success of an artificial neural network depends on the appropriate adjustment of the weights in the model (Elmas, 2003).

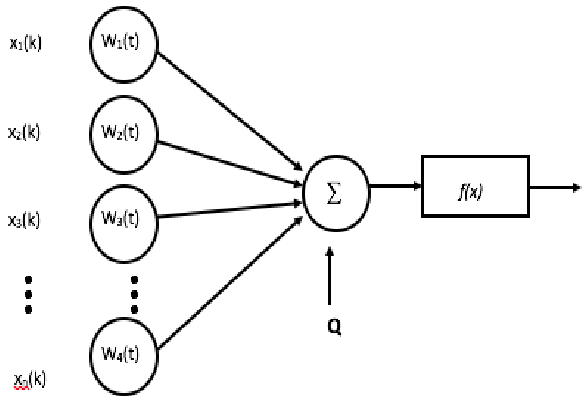

Figure 2. A neuron structure in Artificial Neural Networks (Elmas, 2003)

Although many neural networks are mentioned in the artificial neural network literature, feedforward networks are widely used in the estimation of continuous variables such as price. In feedforward networks, information flows from the input layer to the intermediate layers and the output layer. The learning algorithm compares the values to be found in each iteration with the resulting output and organizes the weights. The most common method used for this is the backpropagation algorithm (Alp & Cığızoğlu, 2004). The backpropagation algorithm works by changing the weight value in each neuron to minimize a loss function (Loss function) by using the sample outputs and the values corresponding to the sample inputs in the learning set. In this way, the weight values with the minimum loss for the training set form the ANN model.

3. Results

3.1. Interpretation of the data set

The fundamental frequency analysis of 70 houses obtained in the study is given in Table 3.

Table 3. Fundamental frequency analysis

Variables		Number	Ratio (%)
Gross Area (m^2)	0-120	13	18,6
	120-179	25	35,7
	180-229	19	27,1
	230 and +	13	18,6
Location of the apartment	Downstairs	7	10,0
	Mezzanine	48	68,6
	Upstairs	15	21,4
Number of rooms	2+1 room	19	27,1
	3+1 room	33	47,1
	4+1 and +	18	25,7
Building Age	0-4	4	5,7
	5-10	12	17,1
	11-15	12	17,1
	16-20	15	21,4
	21-25	19	27,1
	26 and +	8	11,4
Number of floors	0-4	24	34,3
	5-10	21	30,0
	11 and +	25	35,7
Floor location	0-4	39	55,7
	5-10	19	27,1
	11 and +	12	17,1

When we examined Table 3, it was seen that the ratios of the data were close to each other. The ratio of flats with a gross area of 120-179 for sale is 35.7%, the ratio of apartments on the mezzanine floor is 68.6%, the ratio of apartments with 3+1 rooms is 47.1%, the ratio of apartments with a building age between 21 -25 years old It is seen that 27.1%, the rate of apartments with 11 floors and above is 35.7%, and the rate of apartments between 0-4 floors is 55.7%.

According to the data obtained, it has been determined that the most popular flats for sale in Mersin Güvenevler District are in the range of 120-179 m2, with 3+1 rooms, in the age range of 21-25, in the range of 0-4 floors.

3.2. Multiple regression analysis

Data for 70 residences collected is life with Min-Max normalization adjustments 0-1. Averages of normalization values and standard deviation values are given in Table 4.

The independent variables determined in the study (value of the house, gross area, location of the flat, number of rooms, age of the building, coefficient, the floor where it is located, facade, heating, number of balconies, number of bathrooms, site, pool, elevator, security, generator, parking lot, social area and The house price variable changes by 9.2 percent (0.920x100) depending on the doorman. As seen in Table 5, the predictive power of the equation was found to be 92%.

Table 4. The mean and standard deviation of the variables

Variables	Mean	Standard Deviation
The value of the residence	,088	,144
Gross area	,156	,155
location of the apartment	,429	,279
Number of rooms	,271	,254
Building Age	,460	,275
Number of floors	,358	,237
Floor location	,218	,236
Facade	,543	,214
Heating	,460	,502
Number of balconies	,514	,185
Number of bathrooms	,100	,172
Site	,460	,502
Pool	,210	,413
Elevation	,660	,478
Security	,310	,468
Generator	,300	,462
Parking	,530	,503
Social area	,310	,468
Doorman	,370	,487

Table 5. Model summary

R	R^2	Adjusted R^2	Estimation of Standard Error
,959	,920	,892	,0473

The obtained Anova test analysis data are shown in Table 6. When the table is examined, it is seen that the significance level, where the F value is 32,648, is significant according to p<0.01. In this context, it can be said that the model created is a meaningful model.

Table 6. Anova test analysis

Model	Sum of squares	df	Avg. of Squares	F	Meaningfulness
Regression	1,314	18	,073	32,648	,000[b]

The findings regarding the relationship between the parameters of the model affecting the house price and the house price are shown in Table 7.

Table 7. Table of coefficients of the model

Variables	Coefficients	Standard error	T	Sig.
Constant	,028	,037	,770	,445
Gross Area(B)	,896	,083	10,814	,000
Position(K)	,013	,027	,477	,635
Number of Rooms(O)	-,127	,054	-2,348	,023
Building Age(Y)	-,106	,041	-2,603	,012
Parameter(K)	,154	,077	2,012	,050
Floor (BK)	,051	,049	1,037	,305
Facade (C)	,043	,043	1,004	,320
Heating (I)	-2,037E-005	,021	-,001	,999
Number of balconies (BS)	-,091	,046	-1,974	,054
Number of bathrooms (BA)	-,119	,063	-1,885	,065
Site (S)	,001	,026	,021	,983
Pool (H)	,016	,047	,344	,733
Elevation (A)	-,044	,022	-1,943	,058
Security (G)	,010	,049	,197	,845
Generator (J)	-,015	,036	-,423	,674
Parking (OT)	-,029	,025	-1,157	,253
Social area (SA)	,030	,032	,928	,358

When the P values given in Table 7 were examined, it was seen that the gross area was statistically significant according to the p<0.01 level. The housing price equation obtained from the model and the findings obtained are as follows.

$$\textit{\textbf{Housing Price}}\ (\boldsymbol{F}) = 0.28 + 0.896 * B + 0.13 * \mathrm{K} - 0.127 * \mathrm{K} - 0.106 * \mathrm{Y} + 0.154 * \mathrm{K} + 0.51 * \mathrm{BK} + 0.43 * \mathrm{C} - 2.037 * \mathrm{E} - 0.05 * \mathrm{I} - 0.97 * \mathrm{BS} - 0.119 * \mathrm{BA} + 0{,}001 * \mathrm{S} + 0{,}016 * \mathrm{H} - 0.044 * \mathrm{A} + 0.010 * \mathrm{G} - 0.015 * \mathrm{J} - 0.029 * \mathrm{OT} + 0.030 * \mathrm{SA} - 0.04 * \mathrm{K} \quad (4)$$

3.3. Artificial neural network prediction modeling

In this study, the Matlab program was used for ANN analysis. Feedforward backpropagation algorithm was preferred as the network type and trainlm (Levenberg-Marquardt backpropagation) algorithm was preferred as the training algorithm. The ANN architecture used in the study is shown in Figure 3. There are 18 inputs, 10 neuron numbers in the hidden layer, and an output layer.

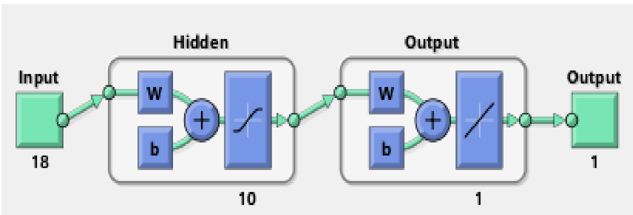

Figure 3. Model of the network

A total of 70 rows of data were used in this study, of which 48 (70%) were used for training, 11 (15%) for testing, and 11 (15%) for validation (Figure 4). The number of hidden neurons used in the network was determined as 25. This ANN was trained with the Levenberg-Marquardt method.

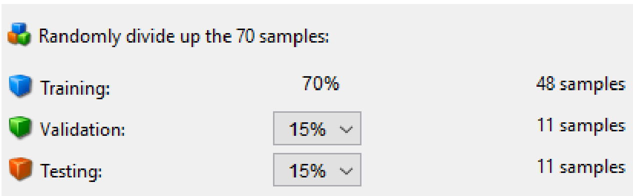

Figure 4. Distribution of ANN training-validation and test data

When the training process was completed, the results shown in Figure 5 were obtained.

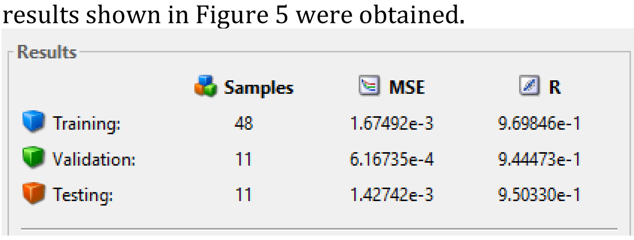

Figure 5. Results obtained

MSE-Minimum squared error is the mean squared difference between outputs and targets. Lower values are better. Zero does not mean error. R-Regression R measures the correlation between outcomes and goals. If the R-value is 1, it means close relationship, and 0 means random relationship.

When the obtained values are examined; the R-value of the training data is 0.969 and the R2 value is 0.940; verification data R-value is 0.944 and R2 is 0.89; According to the regression values obtained, the R-value of the test data is 0.950 and the R2 value is 0.903, it can be said that the estimation is good.

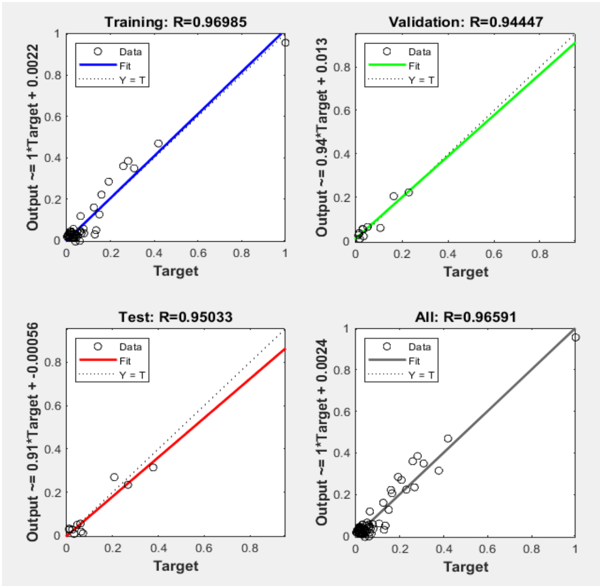

Figure 6. Training, validation, and test scatter curve

As can be seen in Figure 6, the training values are shown for the housing price estimation after a total of 8 iterations. As can be seen, it was determined that the performance of the system was good and it had the best value in the 2nd epoch and the average error rate was 0.000616.

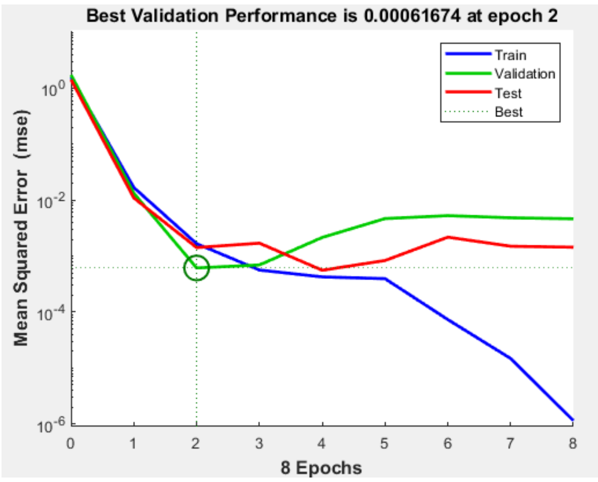

Figure 7. Verification performance

3.3. Comparison of models

The regression analysis model created and the results of the analysis examining the performance of the artificial neural network are given in the table 8.

The mean square error of the generated regression model ranged from -0.037 to +0.037. In the ANN model, it was between -0.029 and +0.029. As a result of the performance evaluation, it is seen that the values estimated by the method using artificial neural networks are less inaccurate.

Table 8. Performance analysis results of the model

Performance Analysis	Regression	ANN
* Average Absolute Percent Error (AAPE)	1,278	0,872
* Mean Square Error (MSE)	0,037	0,0295
* Average Absolute Error (AAE)	0,002	0,001

According to the results obtained, the actual target values (targets) and the outputs obtained from the network and as a result of the regression analysis were compared in Figure 8. When the data is examined, it is seen that both the values obtained from the network and the Regression analysis estimation values are in the appropriate range. While the regression model approaches the price in some plots, it is generally seen that the ANN model is more compatible with the price.

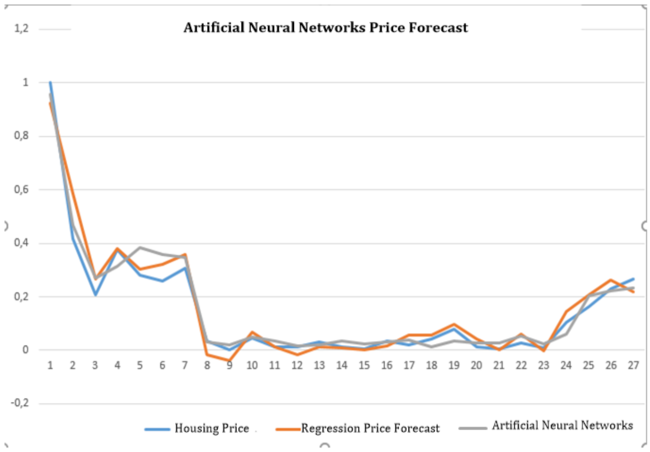

Figure 8. Comparison chart

3.4. Creating value maps

While creating the value map, geographical and descriptive data are associated. Parcel IDs were added to the data with island and parcel numbers, and the data was processed in the ArcGIS program. The current map of Güvenevler District was used as a base. Value map was created by applying Kriging with the geostatistical analysis tool in ArcGIS. The value map created by the ANN method, regression method and normalization is shown in Figure 9. The values of the buildings located in the area close to the 1st ring road of Güvenevler District are low since it is an old settlement area. The values are high as new constructions are seen in the area between the 2nd and 3rd ring roads.

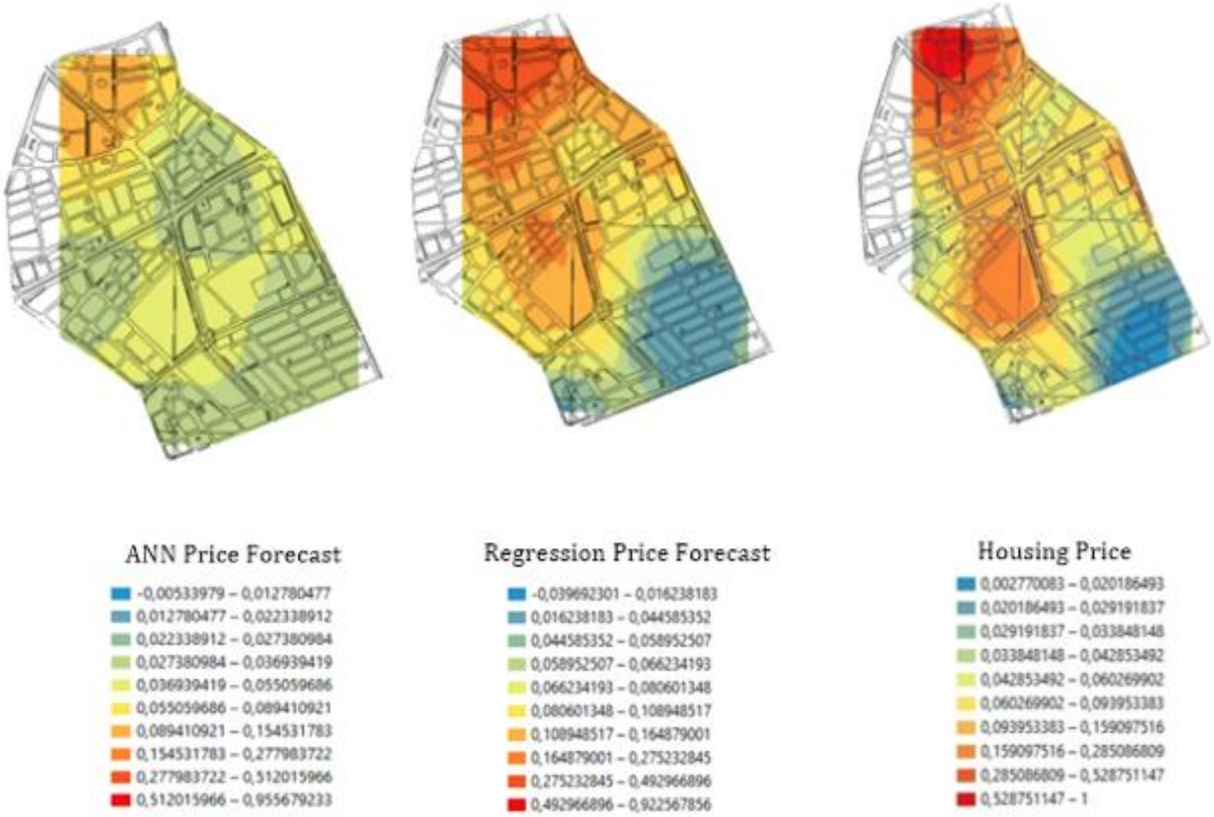

Figure 9. (a) ANN price estimation, (b) Regression price estimation, (c) House price value maps

4. Conclusion

A regression and ANN estimation model was developed by using the data of 70 houses for sale in Güvenevler neighbourhood of Yenişehir district of Mersin province. With the estimation model developed, it is aimed to control the price monitoring of the former settlement of Güvenevler neighbourhood.

The results of the study:

- Modeling using the ANN method can make better price predictions than the model made with Regression analysis.
- The performance of the ANN method is better than the regression analysis.
- Both methods are successful because they give results within certain limits.
- In the regression analysis, the ratio of the independent variables to explain the total variation in house prices is 92%, the remaining 8% consists of unknown factors. In the ANN network, it was found that the rate of explaining the dependent variables of the independent variables was 93%.
- We can say that the number of independent variables used in the study is sufficient. There is a high correlation between independent variables and price.
- As a result of the regression analysis, there is a negative correlation (-0.503) between the price and the age of the building. There is a positive correlation in other variables. In other words, as the age of the building increases, the price decreases. The correlation coefficient between price and gross area was found to be 0.913. It was also observed that there is a very strong relationship between them.
- The buildings located in the area close to the 1st ring road of Güvenevler Neighbourhood show low values as they are the old settlement areas, while the values of the real estates are high due to new constructions in the area between the 2nd and 3rd ring road.

Considering the basic attributes of the flat (area, age, location, etc.), it is foreseen that the unjust treatment will be prevented by making a price determination estimate.

Author Contributions

The contributions of the authors of this article is equal

Statement of Conflicts of Interest

There is no conflict of interest between the authors.

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A geographical information systems (GIS) perspective on European green deal and sustainability

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ABSTRACT

The European Union (EU), known for its sensitivity to environmental and social sustainability issues, especially on topics such as combating climate change, reducing greenhouse gas emissions, and using renewable energy since the 1990s, took these sensitivities one step further in November 2019. In November 2019, it took these sensitivities one step further and presented a package of initiatives, a commitment by the Union to take firm and ambitious steps in environmental and sustainability issues: The European Green Deal. The Memorandum aroused significant repercussions for all state, international organisations and private sector players that have economic, political and geographical connections with the EU, because the Consensus, which consists of the standards set by the EU for its member states, also has the potential to affect the relations of EU countries with third parties. This situation has revealed the necessity of a good understanding of the Agreement by everyone, given the wide commercial and diplomatic ties of the EU. In the geographic data infrastructure designed within the scope of this study, a total of 26 intermediate criteria grouped in 5 main criteria were used. Within the scope of the study, we aim to test the analysis to be made with the availability of quantitative data and topographic data by the European Green Reconciliation. By making use of these data used in the continuation of our study, expert opinions, surveys, etc. can be weighted with AHP or TOPSIS method, and positions, companies, etc. that are important for the Green Reconciliation can be determined.

1. Introduction

Within the scope of the initiative created after the President of the European Commission, German Politician Ursula Von Der Leyen took office on 1 November 2019, it is aimed to complete the transition of the EU to a carbon-free economy by 2050. In order to achieve this goal, the Commission has published the «Sustainable Europe Investment Plan». The Green Deal is the EU's new growth strategy that includes the main objectives of zeroing net greenhouse gas emissions by 2050, decoupling economic growth, and leaving no one and no region behind. That is, the agreement will create jobs and improve quality of life while reducing emissions. At the heart of the core components of the EGD is the aim of transforming the EU economy for a sustainable future. In order for Turkey to continue its cooperation with the EU, it needs to understand the regulations in the sectors that are expected to undergo the most changes and transformations within the scope of the agreement; such as agriculture, electronics, packaging, plastics, textiles and construction including manufacturing branches that provide input to construction. It also needs to follow the developments and develop the ability to take quick steps in adapting the standards to be established (Güçlü, 2021). It is shown in figure 1.

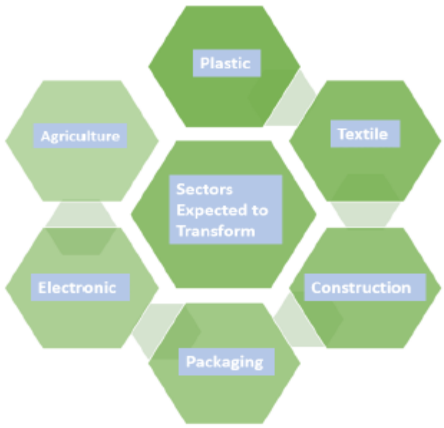

Figure 1. Sectors expected to change and transform the most

The main elements of the agreement for 2030 and 2050 have been identified as follows by the European Green Deal with the aim of making Europe a climate neutral continent by 2050:

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• Clarifying the EU's climate targets for 2030 and 2050,
• To provide clean, accessible and safe energy,
• Mobilizing the industry for a clean and circular economy,
• To follow an energy and resource efficient way in construction and renovation,
• From farm to fork: designing a fair, healthy and environmentally friendly food system,
• To achieve the zero pollution target for a toxic-free environment,
• Accelerating the transition to sustainable and smart mobility,
• Protecting ecosystems and biodiversity (Kaya, 2022).

2. Sustainability

Sustainability is the ability to meet the needs of the present without compromising the ability of future generations to meet their needs (United Nations). The understanding of sustainable development is the structuring of the economic and social development goals of countries according to the principles of "sustainability". United Nations sustainability development goals are No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequality, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life On Land, Peace, Justice, and Strong Institutions, Partnerships for the Goals.

Green Deal that it is not possible for Europe to achieve the consensus environmental target by acting alone. The drivers of climate change and biodiversity loss are global and not limited to national borders. The EU has planned to use its sphere of influence, expertise and financial resources to mobilize its neighbours and stakeholders to join it in a sustainable way. To achieve the goals of the EGD, there is a need to rethink the policies of clean energy supply, industry, production, consumption, large-scale infrastructure, transportation, food, agriculture, construction, taxation and social benefits throughout the economy. To achieve these goals, it is essential to increase the value placed on the protection and restoration of natural ecosystems, the sustainable use of resources and the improvement of human health. This is where transformational change is most needed and potentially most beneficial to the EU economy, society and natural environment. The EU should also promote and invest in the necessary digital transformation and tools, as they are key drivers of change (Görgün, 2021).

3. Geographical Information Systems

The environment, which is defined as where living and non-living beings coexist since the existence of human beings, is at the full focus of life, interacting with the human, plant and animal factors of the main elements such as soil, water and air. In this formation, the interaction of all actors in all aspects creates the life cycle. The survival of human beings in a certain quality in this process takes place within the "rules set" that is set and applied by him. A map, in its simplest definition, is the representation of the land on paper by reducing it to a certain scale. After the positions of natural and artificial objects on the earth are measured by map engineering techniques, their projections on the horizontal plane are presented graphically with lines and special signs. Since today's maps are now produced and stored in electronic media instead of paper, users can be provided with much faster and more detailed information. Depending on the changes in information technology, the need to use computers in order to perform classical mapping operations faster and more accurately has significantly accelerated the development process of location-based information systems. Therefore, traditional paper maps have turned into electronic maps, thus the concept of "smart maps" has emerged (Figure 2).

Today, decision makers need not only graphic but also additional textual information describing object properties. This situation has made it inevitable to create more effective new systems that can combine graphical and textual information. Such shortcomings, initially encountered in CAD (Computer Aided Design) systems, paved the way for the emergence of Geographical Information Systems (GIS) in today's sense. (GIS, 2017).

Figure 2. Database management system

Geographical Information System collects, analyses and presents location-referenced data, which is basically defined as geographical data, with appropriate technological tools. Unlike other information systems, GIS simultaneously stores and processes the geometric information of all kinds of objects on the map in a database. Therefore, there is a feature that is not found in classical databases but only in GIS, which is the ability to analyse "location" based transactions. However, when GIS is considered as a system that manages geographic data rather than a map display tool, five basic components of a geographic information system, consisting of data, software, hardware, people and methods, should work in an integrated structure. In general, data collected by mapping techniques and methods are first stored in computer databases with the help of appropriate software and processed according to user expectations. User requests become guiding for the duplication of information produced by the necessary hardware and for sharing over virtual networks. Data, which is accepted as the most basic element for GIS, is also seen as the most difficult component to obtain. Due to the multitude of data sources and their different structures, data collection, organization and verification in GIS requires at least more than half of all the time and cost of a system to be established.

3.1. Widespread impact and application areas of GIS

Geographical information technology has a wide range of applications used in many sectors. GIS is included in all kinds of applications related to location information. GIS has started to be used as an important common concept in many applied professions such as land management, planning, agriculture, forest, landscape, construction, geology, climate, atmosphere, defense, safety, tourism, archeology, local government, population, education, environment and health. Processing and analyzing large volumes of data based on geographic information and making decisions based on the results is only possible with the effective use of GIS. When we look at the common usage areas mentioned above, it is observed that almost all of them coincide with the areas of interest of EGD (GIS, 2017) (Figure 3).

Figure 3. Classification of geographical data used

3.2. Database and database management systems

A database can be defined as a dataset that typically describes the activities of one or more organizations. If we can store these databases on a computer using various software such as spreadsheet software, and even enable others to access these data in a controlled manner and perform operations such as adding and changing on the data, then we have a "database management system". Today, the term Database Management System (DBMS) is understood as software systems that contain databases, allow users to be authorized, provide various data access and data processing functions and interfaces, and contain supporting mechanisms such as backing up and repeating data (Figure 4) (Ergünal, 2021).

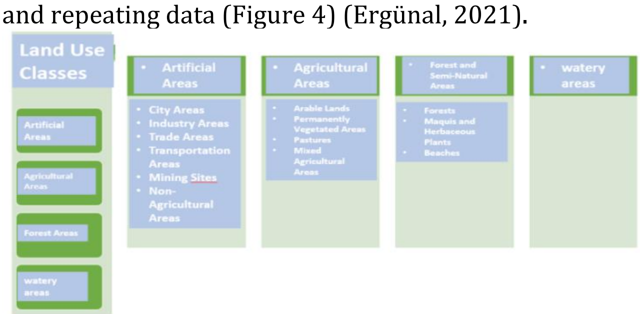

Figure 4. Geodatabase

When the system is examined in the context of EGD interests and topics, it will be observed that a large number of public institutions and organizations and the activities carried out in this context by the private sector can talk to each other under a single roof, repetitions can be avoided, and an efficient and effective structure will be achieved. The most important advantage of using database management systems in the processing of geographical data is that geographical and no geographical data are collected in a center, on a single system, and more efficient data processing, sharing, protection and backup opportunities are obtained within a geoportal architecture (Figure 5) (Erginoğlu, 2021).

Figure 5. The importance of 3D geographic data

4. Major EGD Topics and New Geographical Data Concepts in This Framework

EGD has brought many new terminologies with it to the present day such as: Green and Circular Economy, Green Finance, Sustainable Agriculture, Sustainable Smart Transportation, Green Logistics, Carbon Neutral, Green Building, Emissions Trading System (ETS), Border Carbon Regulation Mechanism (BCRM). All of these include the main descriptions of the arrangement of natural or man-made objects on the earth's geography within the scope of EGD When the subject is geography, that is, a spatial structuring that includes all of the earth's and underground riches of the atmosphere, it has been evaluated that it will be important to emphasize the necessity of geographical data and to highlight the issues of LULUCF and Green Cadastre, which symbolize sustainability in the best way, so that the most appropriate use of this geography, which we call environment, can reach future generations (Taşkıran, 2020).

Carbon Absorber: They are natural or man-made systems that absorb and store carbon dioxide from the atmosphere. Forests are the most common type of pharynx. Also, soil, peat, permafrost (permafrost) soil layers, ocean water, and carbonate sediments in the deep ocean are other forms of sink.

Carbon Capture: It is the process of capturing and/or removing carbon from the atmosphere and storing it in a warehouse in a way that prevents it from being released into the atmosphere for a specified period of time.

Importance: CO2 in the atmosphere can accumulate in terrestrial ecosystems as carbon by photosynthesis in vegetation and soil. Under the United Nations Framework Convention on Climate Change (UNFCCC), any process, activity or mechanism that removes greenhouse gases from the atmosphere is called a sink. Through human activities, land use, land use change and forestry (LULUCF) activities, the exchange of CO2 (carbon cycle) between terrestrial sinks and thus the terrestrial biosphere system and the atmosphere can be altered. LULUCF Sector consists of 6 land uses. These are Forest Areas, Agricultural Product Areas, Pastures, Wetlands, Settlements and Other Areas (Rocky, sandy lands). In LULUCF sector, in addition to land uses, there is also a resource sub-sector Wood Products (Timber, Panel Products, Paper-Pulp).

Agriculture and forestry are two important sectors that affect and are affected by climate change. Greenhouse gas calculation studies in the LULUCF sector are carried out in Turkey with the coordinated work of the General Directorate of Forestry and the General Directorate of Agricultural Reform (Figure 6) (Acar (2021).

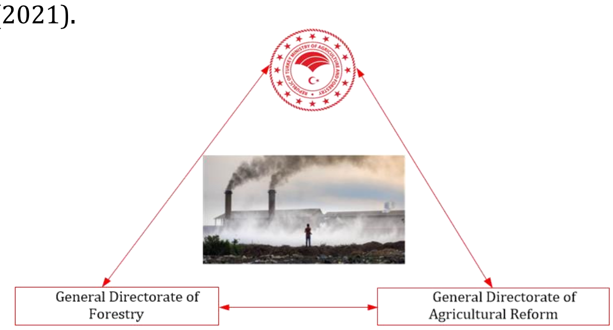

Figure 6. Greenhouse gas calculation studies

Another prominent land use in the LULUCF sector is wetlands. The amount of carbon accumulated in wetlands accounts for one-fifth of all carbon on the planet. This is a value equal to the total carbon in the atmosphere. Therefore, the protection of wetlands, especially peatlands, is of critical importance in the fight against climate change. Today, half of the world's population lives in cities. In the next 40 years, the urban population is expected to exceed 2.8 billion people. As a result, for example, in 2030, residential areas will need to increase by 250%, i.e. 1 million square kilometers. In the fight against climate change, a correct urbanization approach with green areas should be seen as a basic and critical solution approach. One of the important goals within the scope of combating climate change is to balance greenhouse gas emissions and attitudes. In this context, the importance of LULUCF, which is the only sector in which carbon sequestration is calculated in the greenhouse gas inventory, emerges.

4.1. Green cadastre

Green Cadastre; It is a new term that has emerged to help today's urban and rural areas become greener. It covers the processes for mapping, recording, and cataloging all public green spaces, including every shrub and tree. The creation of the "green cadastre" is part of a program that aims both to promote the expansion of green areas for urban and rural areas in line with European norms, and to improve the city's preparedness, in particular, for natural disasters and climate change. Experts have long argued that to improve planning and policy making, the countryside and the city need a complete record of parks and other green spaces, including all plant species. Conservation of green spaces is very important for environmental reasons as well as for the health and quality of life of urban and rural residents (TOBB, 2021). Gündüz & İyiler (2021) UNDP emphasizes that establishing a green cadastre will especially help to increase the urban resilience of cities and the city will need to develop strategies to deal with the future effects of climate change on urban infrastructure (Figure 7).

Figure 7. Sample green cadastre draft study

The green area cadastre is the basis for the efficient and cost-effective management of green areas and facilities. Access to up-to-date data simplifies planning for manpower allocation and machine operation. Besides allowing the economical and targeted use of materials, it ensures the optimization of the entire business operation and at the same time increasing cost transparency. Existing property data held by government authorities is of essentially limited value for greenfield cadastre, as it does not provide a description of objects or information about the use and condition of your facilities. These factors are absolutely essential for the efficient management of green space. Here, the use of GIS for the management of all kinds of geographical data is of great importance. The reduction in farmland area resulting from global population growth requires active monitoring and protective measures to prevent the loss of this valuable resource. Currently, most countries do not have a geographic information system that comprehensively supports agricultural policy. However, there are many dispersed systems containing various data on agricultural production. The analyzes reveal that a reference Land Management System (LAS) integrated with farmer databases can contribute to the monitoring of farmland and support agricultural policy (Noe, 2019).

5. Conclusion

The basic fuel of the technologies (Big Data, Cloud Computing, Internet of Things, Artificial Intelligence, Sensors, Virtual Reality, Platforms, Drones, 3D Printer, Simulation, Smart Cities, etc.) of the Industry 4.0 Revolution we live in is "Digital Data". A large part of this data is within the scope of "Spatial (Spatial)", that is, "Geographic Data", and the process of collecting this data and converting it into "Geographical Information" together with the content of the attributes is directly in the field of interest of the "Map and Cadastre" sector. The biggest negativity created by the industrial revolutions, which have been going on for more than 200 years and especially today, has resulted in a significant deterioration in the balance of nature and life. The climate change caused by the greenhouse gas effect, with the production frenzy as a result of the industrial revolutions, is rapidly leading to a world that cannot sell its production in the near future. Efforts such as the European Green Deal, Paris Climate Agreement, and COP 26 that emerged in order to put a stop to this negative trend stand out as mechanisms to regulate activities that will minimize the negative effects in different areas of production. The multiplicity of areas that create negativity (construction, energy, transportation, etc.), the search for solutions within each area and the efforts to create a set of working groups for this brought along the necessity of continuing the work done on a common ground. Climate change directly affects the geography of the earth, and its atmosphere, aboveground and underground elements take their share from this change (Önder, 2019; Melik, 2020).

The solution goes through a structure which not only seriously analyzes the geographical data collected by various sensor systems (Digital camera, Lidar, etc.) from the air (airplane, drone, etc.), from space (satellite) and on the ground, from the past to the present, but also provides new data that the areas where negativities arise on this geography promptly with new measurement and mapping techniques when necessary. By creating a database based on GIS and supported by Industry 4.0 technologies as a common denominator, it will be possible for different sectors to talk to each other through this base, to observe the adequacy levels of the efforts, to monitor and question the measures taken, and to provide an EGR infrastructure that facilitates the work.

Author Contributions

The contributions of the authors to the article are equal.

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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