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An Entity-Relationship Model for Forest Management Unit Case Study: Kheiroud Forest

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Abstract: The principle objective of this research was to design conceptual data model for Hyrcanian forest. The data model is based on E-R diagram as useful tool for designing the data used in data model. As a result a forest conceptual data model describes system elements and their relationships in Hyrcanian forest unit. It can be used as a primary core of a more comprehensive forest information system. Finally, this study indicates the advantages of designing conceptual data model for Hyrcanian forest management.

Key words: Conceptual data model, entity relationship model, spatial data, non-spatial data, Arc view 2.3a

INTRODUCTION

The term system is at the top of all popular concepts and commonly used words. This concept has gained in popularity in scientific context penetrated into public voice, professional-technical expression and mass media (Bertalanffy, 1976). In general from the view-point of management concerns, forest is one of the most complicated biological systems as its management requires as to study the whole actions and reactions (interactions) within its diverse components and to incorporate the necessary information in to control and management techniques. Basically forest information system is designed so, as to improve its management approach and it is a kind of system intended to record, save process and display forest spatial and non-spatial information to accomplish the planning, implementation and the precise control of operation present of the forest (Feghhi, 1998). Conceptual data model is generally used for engineering information modeling at a high level of abstraction (Sousa *et al*., 2002; Ma, 2005). Depending on data abstract levels and actual applications, different database models have their advantages and disadvantages. It is important to make conceptual model to be understandable for stakeholders, analysts and designers (Gemino and Wand, 2005). From aspect of data modeling, forest can be a set of land compartments which has or could have tree vegetation and is managed as a whole to achieve tree-related owner objectives (Davis and Johnson, 1986 Cited by: Baskent *et al*., 2001). An object can has two aspects for study description and location. These two aspects are related to each other, so the data used in forest data model are two types: non-spatial and spatial data (Baskent *et al*., 2001).

In this study we designed non-spatial forest data model and it can be related to spatial model. However in this study we argue about non-spatial aspect of the data model. Tokola *et al.* (1997) designed an entity-relationship model for forest inventory for Finnish forests and described that it can be applied to other natural resources data management cases and Feghhi (1998) designed a conceptual data model for Swiss forests. The data model was based on entity-relationship model and consists the spatial and non-spatial data as Tokola`s model. Frehner *et al.* (2006) designed a conceptual data model for virtual data bases as an integrated model to analyze spatial and ecological data stored in distributed data repositories. In all of designing the conceptual model quality is important, it can be of significant on the efficiency (time, cost, efforts) and effectiveness (quality of result) of information system development (Moody, 2005). Some factors can influence designing conceptual data model. Davies *et al.* (2006) described the impact of two factors: organization size and years of experience in modeling on designing conceptual data model. About the last issues the choices to draw up conceptual data model, but it would very much depend on experiences concerned. Each database may be completely unique because there is no single common model for designing databases. Eichman (1998) evaluating the quality of conceptual models is still very much more art rather than science. The dimensions of quality have only

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recently been defined and explored. Quantitative methods for evaluating the quality of a model are virtually nonexistent. A possible method to develop quality frameworks is to analyze conceptual data modeling errors which occur in practice (Moody, 2005).

This study presents conceptual data model designed for forest management system. It can be related spatial data and it can be used as a primary core of a more comprehensive information system. This system has its own functions making efficient management possible for the system and could meet users' managing requirements. An forest information system should be able not only to carry out required numerical procedures but modulate and predict future forest situation.

MATERIALS AND METHODS

Study area: Designing conceptual data model takes place as a case study at the Kheiroud forest in Nowshahr, Iran. This study started in July 2007 and finish 5 month. Extension station of Kheiroud, an 8000 ha area, is located as 7 km east far from Nowshahr. The lowest part, also northern border, is 10 m higher than sea level extending to 2200 m height. In 1962, Faculty of Natural Resources (University of Tehran) took charge of Kheiroud forest from the ministry of natural resources for training purposes. The forest land has been divided into eight Districts, three of which have been provided with management plans by now. The area of each district is about 1000 ha and each of compartment is 50-80 ha. Public sector is in charge of Kheiroud; the faculty is actually a public executive agent. The plans are compiled for a 10 years mid-term period. The whole planning program take place in compartment level, so this level is very important for forest planning and management. In this study the conceptual data model based on E-R model. This basic notation of Entity-Relationship Modeling was introduced by Chen Ryan and Smith (1995) and Ponniah (2007). The entity-relationship model describes that the real world consists of entities and relationships (Chen, 1976). This method as popular way of designing conceptual data models is a dominant method (Genero *et al*., 2007; Muller *et al*., 1999). We used of Gee! Version 1.1 as suitable (CASE) tools for designing.

Methods: There are three types of data relationships: one-to-one, one-to-many and many-to-many (Awad *et al*., 1995) that we used the data model. Present designing strategy was inside-out method (Ryan and Smith, 1995). There are other strategies but none of the strategies is entirely satisfactory by itself Heminger and Robertson (1998). In this way; we first used minimum essential information to implement the forest management plan. This was Top-down method , but it required the designer to know comprehensive information, so in next phase we design a small- size data model based on minimum information and try to study the limitation of the data model.

RESULTS AND DISCUSSION

Every forest has its own functions and capability that distinguish it from other forests, considering the above-mentioned characteristic forests are highly valuable for different stakeholders. In the case of viewing forest as a live, dynamic and complicated system, this system is regarded as one of special components through which can control the components of the whole system. Due to extensive and unpredictable variations within the forest one can not study and analyze it without the model because of this we should find answer to the basic questions:

- What components does forest management system have?
- How are these components interlinked?

The components of forest management system can be designed through understanding existing functions at a forest. In fact these functions may be the same expectations likely managers will make in future, for example a forest productive and socio-economical functions as a result one can draw the conclusion that also managers information requirements will fall into these three fields in future. It's natural to include the information and it should be kept in mind that having these three parts is essential, so this model allocate a particular part for cutting and marking or for environment issues to protect animals and plant species. Conceptual data model of Kheiroud forest is designed based on different kinds of operations of forest (forest, Districts and compartment). The principle objective of designing the model was to answer managers` free basic questions i.e. time, place and the type of operations involved at the forest. Finding answer of these questions will extensively help the planning that would take place at the forest in future (Fig. 1).

Designing the model began at three key area: These include forest, districts and compartment. The above parts are designed as related entities whereby connected to a central entities calls operation. The other operations are separately linked to these three main parts. The importance of operation entities is in indicating the time of doing the operations at the forest. The planned entities on this model have descriptive features accounting for

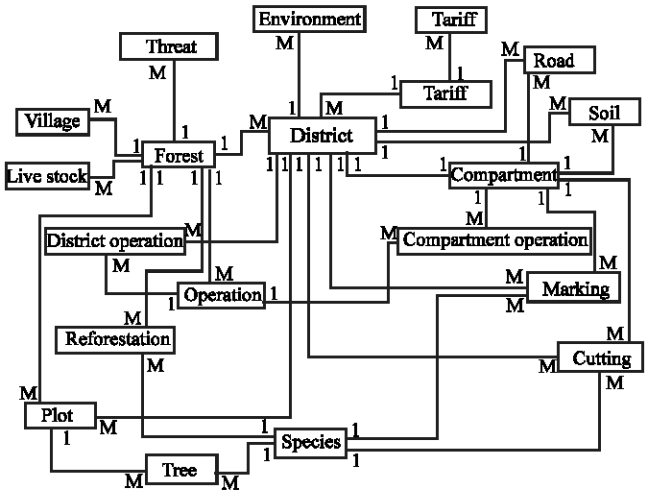

Fig. 1: Kheiroud forest conceptual data model

phenomenon in question e.g., (forest name, ownership, ancientness) or (operation name, the starting time of operations, etc).Generally in this made, forest operations are questioned in two ways:

- Descriptive information of operations such as time
- The place of operations

Undoubtedly the place of operations is displayed as the special software like Arc view 2.3a either in form of polygon, lines or points. The type of relationship among these components is so important. In this designing three main relationships including (1-1), (1-M) and (M-M) are used. The most complicated and time demanding part of designing the model is to determine the accurate relationships among the mentioned components. For instance at first glance the relationship between reforestation and compartment can be discussed as many-to-many relationship, i.e., several reforestation treatment are performed in each compartment and each reforestation in turn can be performed in several compartments. With a little speculation one can realize that the relationship between the two entities is not compatible, as time factor is ignored in the model. This relationship can be restarted once again as follow:

In every compartment several reforestation treatments are possible to be performed at different time period, but a particular reforestation operation at given time can be done only in one compartment as a result this relationship is one to many. In fact on the 5th of February 1995 in compartment No. 206 only one relation reforestation operation for 27 seedlings of oak species has been conducted. Such considerations must be attributed to all other entities individually. Although it is not far-

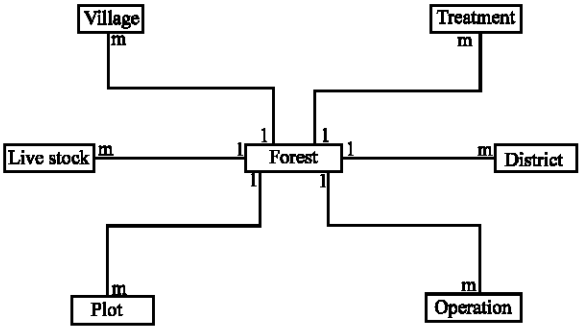

Fig. 2: Relationship of forest entities with other entities at Kheiroud conceptual data model

fetched that due to similarity among same function of the entities designed to this forest and similar entities in other designed models, every one can observe these types of forest on the other areas of the model as well. Yet these relations differ from each other according to various management styles within every single forest.

Model concepts and their relationships

First key part (forest): This part has some relationship with entities called (ranchman, village area, threats). The type of relationship with each other entity is one-to-many. The livelihood stock entities provide information about the number and kind of villagers `stock. In village entities also information accounting for name and number of villages within the forest level is available .The threats entities also consists of a brief history of threat, the kind of threat and its causes (Fig. 2).

Second key part (district): This part is directly connected with entities of (soil, road, marking, cutting and plot) and

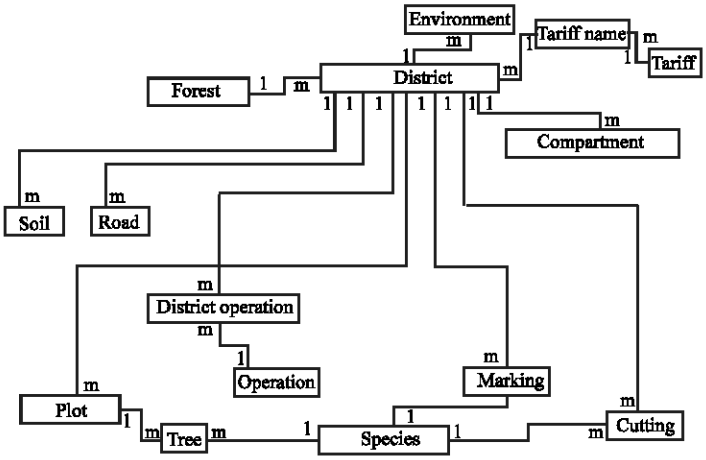

Fig. 3: Relationship of district entities with other entities at Kheiroud conceptual data model

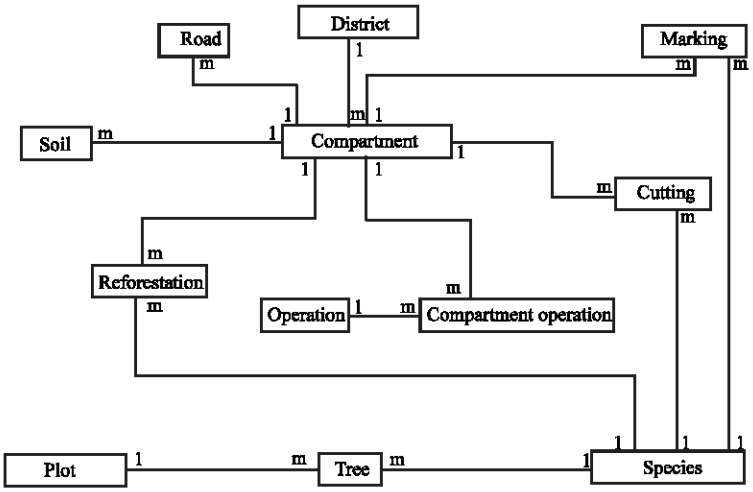

Fig. 4: Relationship of compartment entities with other entities at Kheiroud conceptual data model

indirectly linked to entities of species (Fig. 3). The relationship of the entities with entities of district is one-to-many. In fact a district is a management unit of Kheiroud forest, so most of operations are required at this level, for example at Kheiroud forest inventory operations are conducted at given size of plot level and eventually determine information like volume balance per hectare and density of stands to the all districts. It's obvious that several plots with unique numbers can be present in each district, but a particular plot with a given number just belongs to a special district of the forest. This relationship is not so important as long as the place of a plot is determined in districts. For instance, when and at what districts plot No. 1229 is cut? Calculations related to volume balance also are determined by tariff entities which are unique for each district. Every district has only tariff entities, but tariff entities can be used for different districts (one-to-many). A special point about tariff entities was that its nature was defined as an entities rather than a record. In all relations present at this model a record from an entities is linked to a record from another, but at current relationship an entities (tariff) is linked to a record from districts entities. To remove this problem another entities (Tariff Name) was used. To provide answer to the whole inquires at the tills of species prevent in each operations within the model the entities of species is available.

Third key part (compartment): Compartment entity has some relationship with all entities relating with district. The type of the relationship is one-to-many. There is an entity called reforestation that only is related with compartment. This relationship is for reason that most of the information that the managers need to reforestation

are inquired at compartment level because compartment is the unit of planning (Fig. 4).

CONCLUSION

In general in the designing process of such a model one should carefully bear in mind that in what fields and what levels the highest inquiries are made Kheiroud conceptual data model will be the initial core for a complicated and rather big one. Also it can design and add new entities to the model by changing management styles.

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