SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY

(Approved by AICTE & Affiliated to JNTU, Anantapur)

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the Project work entitled "**SPATIAL DATA MODELING WITH DEFORESTATION FACTORS USING UML**" being submitted by

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in partial fulfillment for the award of the degree of **Bachelor of Technology** in "**Computer Science & Engineering**" discipline is a bonafide project work carried out by him/her from **Siddharth Institute of Engineering & Technology** during the period 2012 - 2013.

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Submitted for Viva voce Examination held on______________________

Internal Examiner **External Examiner**

ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without the mention of the people who made it possible, without whose guidance, encouragement and help this venture would not have been success. The acknowledgement transcends the reality of formality when we would like to express deep gratitude and respect to all those people behind the screen who guided, inspired and helped us for the completion of our project work in time and up to the standards.

We owe our gratitude to our Honorable Chairman Dr. K. ASHOKA RAJU, Ph.D., and also deep sense of gratitude to our Principal Dr. K.CHANDRA SEKHAR REDDY, M.TECH, Ph.D., for having provided all the facilities and support in completing our project successfully.

We owe our deep sense of gratitude to our Mrs. P.NIRUPAMA, M.E., Professor & Head, Department of Computer Science & Engineering for her valuable guidance and encouragement given to us during this project.

We express our deep sense of gratitude to our project guide Dr. K.R.MANJULA, Professor, Department of Computer Science & Engineering, who evinced keen interest in our effects and provided her valuable guidance throughout our project work.

We are thankful to **All Staff Members of C.S.E department** for helping us to complete this project work by giving valuable suggestions.

We are very much thankful to the IEEE Standard Education Committee to their support and grant extended to the project with the name of IEEE Mini Grant.

The last, but not least, we express our sincere thanks to ALL OUR FRIENDS AND PARENTS who have supported us in the accomplishment of this project.

A Project Report

on

SPATIAL DATA MODELING WITH DEFORESTATION FACTORS USING UML

Submitted

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Under the noble & esteemed guidance of

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SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY

(An ISO 9001:2000 Certified Institution)

(Approved by AICTE, New Delhi & Affiliated to JNTU, Anantapur)

2012 – 2013

CONTENTS

ABSTRACT

The growing complexity of engineering tasks creates a need for tools that offer possibilities for high quality situation monitoring and comprehension, as well as prediction of our future line of action. The increasing use of geographic data and Geographic Information Systems (GIS) calls for research within geographic data modeling and data bases. Along with the growing use of geographic data, it also becomes necessary to exchange and combine heterogeneous data, which refers to the same phenomena, between different authorities and systems. Typically these data are collected and organized different on basis of non standard data models, which again are application-dependent. This makes the exchange of data a challenging task, and in order to be accomplished successfully, it requires well documented and well organized data. Developing comprehensive standard data models will create the basis to make the exchange of data a more trivial task. Detailed conceptual models are necessary, when developing systems for geographic information to ensure consistency and integrity. It is well documented in literature that geographic data have special characteristics and call for extensions to standard modeling languages and techniques like the Unified Modeling Language (UML).

This project deals with the geographic data modeling requirements as perceived by the use in natural resource maintenance. This project investigates common properties of geographic data and for the deforestation factors that is obtained by classifying the Remote Sensing images with various time periods. For most case study is presented to show how the requirements can be modeled using existing developments of techniques and models to handle geographic data.

1. INTRODUCTION

The growing complexity of engineering tasks creates a need for tools that offer possibilities for high quality situation monitoring and comprehension, as well as prediction of our future line of action. The choice of an appropriate representation for the structure of a problem is perhaps the most important component of its solution. Over the years a great deal of data has been accumulated, much of it duplicative and disorganized. Data was developed in a stovepipe fashion with little or no coordination or consideration of related data. Data standards, when developed, were done because of the interest of a small group of individuals, not necessarily in priority areas. This has lead to redundant data, problems with data quality, and a lack of understanding of what data is available or where to find it (which in turn led to more redundant data, more data quality issues). Geographic information systems (GIS) are precisely such a tool. They offer support for implementation of various types of projects aimed at economic development, resource management, and *high quality decision making*. According to a general definition, geographic information systems are a powerful set of tools for collecting, storing, searching, transforming and presentation of real word spatial data. GIS can also improve various everyday procedures by offering fast access to data necessary for decision making on a large number of issues. Capacity of any information system largely depends on its data model. Therefore, for an integrated information system, a rigorous data model is vital and to have a rigorous model for any information system, basic concepts of its domain have to be considered, which have been elaborated in this project. UML is chosen as the modeling language because it has become widely used both in academia and in the industry. It is now a standard defined by the Open Management Group (OMG) and is also proposed as an ISO standard (DIS19501) [ISO, 2000]. UML is furthermore used in the standardization work within Geographic Information done by ISO (ISO TC211).

2. SYSTEM STUDY

2.1 PROBLEM STATEMENT

Data are collected and organized different on the basis of non standard data models which again are application dependent and exchange of data becomes a difficult task. We need well documented and well organized data .Geographic data consist of location and extent, which is not supported by standard modeling languages like UML .Here developing comprehensive standard data models will create the basis to make exchange of data a more trivial task. From data modeling point of view this present interesting challenge since the level of complexity becomes high so that the resulting database schema becomes unusable.

2.2 EXISTING SYSTEM

In the project titled," Using UML Case Tool for Development of an Open Pit ArcGIS Geodatabase" deals with extension of opmGIS system with thematic classes related to production, integration with deposit modeling tools and 3D extensions. In the project titled as "How to Design Geographic Databases? Specific UML Profile and Spatial OCL Applied to Wireless Adhoc Networks" deals with OCL extensions can be easily adapted to new topological relations. In this case GIS define simply has to give the semantics of the new topological relations between pairs of geometrics. In the project titled, "Modeling Geospatial Application Databases Using UML", the authors concentrated their work on UML static diagram. In the project titled, "Modeling Of Geographic Data Using UML" specifies that associations between objects, constraints, generalization and quality are important to consider when modeling geographic data.

Drawbacks:

- The outlined solution is the only the first step in creating an integral GIS system for mine.
- When the designer writes the system specifications the visual representation of geographic data becomes unnecessarily because all spatial features are declared in UML diagram and in OCL expressions.
- Aspects such as what define a role and how roles could be used in a distributed environment need to be investigated.

2.3 PROPOSED SYSTEM

Design and interpretation can be presented differently. As UML has become widely used both in academic and industry, it is now a standard defined by OMG (Open Management Group). UML is also proposed as ISO standard.UML is further used the standardized work with geographic data information done by ISO. UML covers simple concepts and is very intuitive and easy to use. Association between object, constraints, generalization, quality are important consider modeling geographic data.

In order to solve this problem, we propose a solution based on UML object class model that has been extended to better accommodate spatial data. The proposed solution uses UML stereotypes to represent in a very simple manner (all the 0D, 1D, 2D geometries that an object can have).This solution also supports geometries as well as the derivation of attributes, objects/classes/association. It has been implemented in a free visual modeling to temporal multiple representations and generalization.

Advantages:

- It supports to create webGIS portal with contents from this project

- It can provide a frame work to express complex topological constraints.OCL is standard constraint language associated to UML.UML specification of this development will completely validate our profile.
- It can find a balance between the two i.e extended UML and perceptory to develop a notation that covers the important aspects but simple to use.
- It has been demonstrated how, by means of a visual representation, database users(managers,mining engineers,geologists,….) can have a clear picture of the entire system,and at the same time easily access alphanumeric data.

3. REVIEW OF LITERATURE

Anders Friis-Christensen [1] proposes the ***geographic data modeling*** requirements as perceived by the Danish National Survey and Cadastre (KMS) and focuses on ***spatiotemporal properties*** and ***roles*** of geographic objects. ***Changcheng Dong***[3] suggest a new approach to ***spatial data generalisation*** using objectoriented techniques by using the ***Object Model*** and Dynamic Model of OMT, the ***relationships*** between different ***feature classes*** can be examined and the generalisation processes analysed. ***Cliff Kottman*** [4], the ***OpenGIS Specification*** serves as the technical basis for the Technology Development Process which is realized according to a plan and schedule developed by the Technical Committee.

Dingfei Liu [5] has developed a ***framework*** based on object orientation for MCDM and ***DSS modelling***. ***GAO Wu-jun*** [7] has a brief discussion to spatio-***temporal data model*** and ***visualization*** of data model, integrate time with spatial data. **Indira Mukherjee** [9], has been proposed a framework to **integrate** various ***heterogeneous databases*** through ***geospatial data modeling*** and ***spatial web services.*** The data model has been done using Unified Markup Language (UML). ***Jean Brodeur*** [10], suggest the result of recent work on the use of ***geospatial repositories*** to store the ***conceptual*** content of object oriented application ***database schemas*** and dictionaries aligned with international standards in geographic information (ISO/TC 211 and OGC). ***Jugurta Lisboa-Filho*** [11], devised a ***UML Profile*** which allows a structured and precise UML extension, being an excellent solution to standardize ***domain-specific modeling***, as it uses the entire UML infrastructure. This article proposes an UML profile developed specifically for conceptual modeling of geographic databases called GeoProfile.

Kehe Wu [12], proposes a method for modeling ***power spatial data*** based on ***object-relational model*** and discusses the methods to organize, manage, and query spatial data based on the model. ***M. Kumar*** [13], developed data model and has been used as a method for developing a ***coupbled GIS interface*** to Penn State Integrated Hydrologic Model (PIHM) called PIHMgis. ***Michael F*** [14], suggested the specific object-oriented data model ***IFO***, concludes by discussing current research issues and directions in this area. ***Myoung-Ah Kang*** [15], describes a specific formalism for ***geographic database design*** and a complementary language for the expression of topological constraints, precise and easy to use textual representation of type constraintsd.

Saeed Nadi [18], explores the principal concepts of ***space-time*** and other relevant parameters in a ***temporal*** GIS. ***Sajayasree K K*** [19], specify unambiguous constraints so-called formal languages have been developed. ***Stanley C*** [20], presented ***re-design*** data holdings to be more efficient, eliminateredundancies, and simplify data structure. ***Tomašević Aleksandra*** [21], outlines a ***methodology*** for development of a ***spatial database***, tackles exploration works, sample analysis, infrastructure within the mine and in itsenvironment, excavating and loading equipment, etc. ***Vania Bogorny*** [22], presents an extension of the classical open source data mining toolkit Weka to support automatic geographic data preprocessing.

4. SYSTEM ANALYSIS

Systems Analysis is the process of investigation of a system's operation with a view to changing it to new requirements or improving its current working. System Analysis is a process of collecting factual data, understand the processes involved, identifying problems and recommending feasible suggestions for improving the system functioning. The result of this process is a logical system design. Systems analysis is an iterative process that continues until a preferred and acceptable solution emerges.

TYPES OF FEASIBILITY STUDY

Economic Feasibility: It is also known as cost benefit analysis. If benefits outweighs costs, then the decision to made to design and implement the system.

This project economically feasible and achieves cost benefit by supporting the customization of database according to the needs and supports reusability. Thus it reduces the cost of constructing the database.

Technical Feasibility: It checks whether the existing computer system supports the candidate system it or not up to what extent it supports.

This project support basic technology with extended featureset so that with existing tools and system configurations project can be implemented.

Behavioural Feasibility: An estimate should be made of how strong a reaction the user staff is likely to have towards the development of computerized system.

This project support basic technology with extended featureset so that with basic knowledge the project can be implemented.

5. REQUIREMENT ANALYSIS

Requirements analysis is critical to the success of a development project. Requirements must be actionable, measurable, testable, related to identified business needs or opportunities, and defined to a level of detail sufficient for system design. Requirements can be functional and non-functional.

5.1 SOFTWARE REQUIREMENTS

- ArcGIS 10.1
- Enterprise Architecture 9.3
- Windows7

5.2 HARDWARE REQUIREMENTS

- Processor : i3, Dual core
- Display Properties : 24bit-colorlength
- Processor speed : 2.2 GHz minimum or higher;
- RAM : 2GB

Creating a collection of these dataset types is the first step in designing and building a geodatabase. *In this project these elements are designed through appropriate model.*

The CASE tools subsystem of ArcGIS has two parts: the Code Generation Wizard and the Schema Wizard. *This project discusses how to create each component of our geodatabase schema in UML using Enterprise Architect and how to use the CASE tools in ArcCatalog to generate the schema for our UML design.*

6. METHODOLOGY

6.1 DATA COLLECTION

The application of GIS is especially important in the environment protection area, as it enables active monitoring of the impact of deforestation factors to environment: air, water and soil quality, determination of the level of risk to human health, flora and fauna, as well as planning of protection measures.

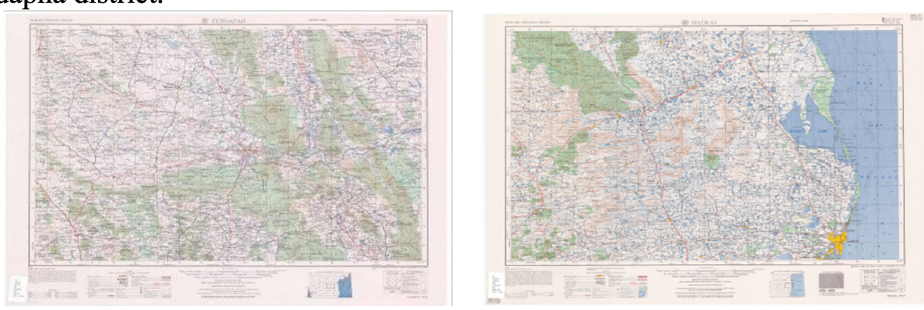
STUDY AREA

The setting of this study spans an area of 5000 Square Kilometers and the study area boundary in lat-long E 79 39" to E 78 45" and N 13 35" to N 14 33".

Beside the undamaged natural environment in some parts, a big part of the area has been changed by agriculture and grazing activities. Spatial information on Land use / Land cover is a necessary prerequisite in planning, utilizing and management of the natural resources. Three kinds of data are used for this project:

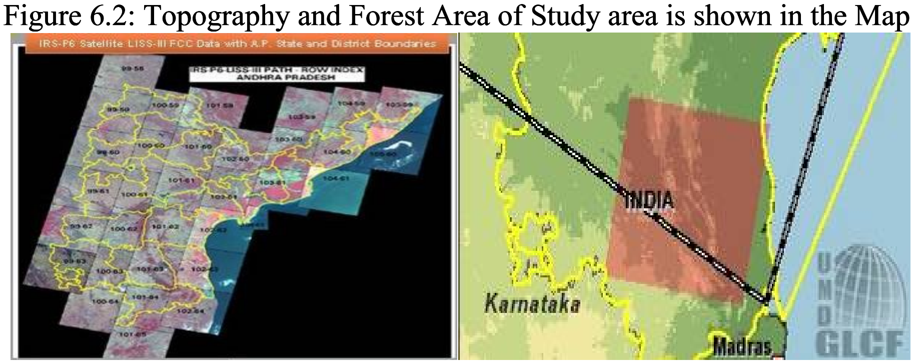
- Satellite data,
- Topographic and thematic maps and
- Descriptive data.

The following figures represents toposheets, satellite images path row of the study area and scene and satellite image along with scanned mandal boundary map of Cuddapha district.

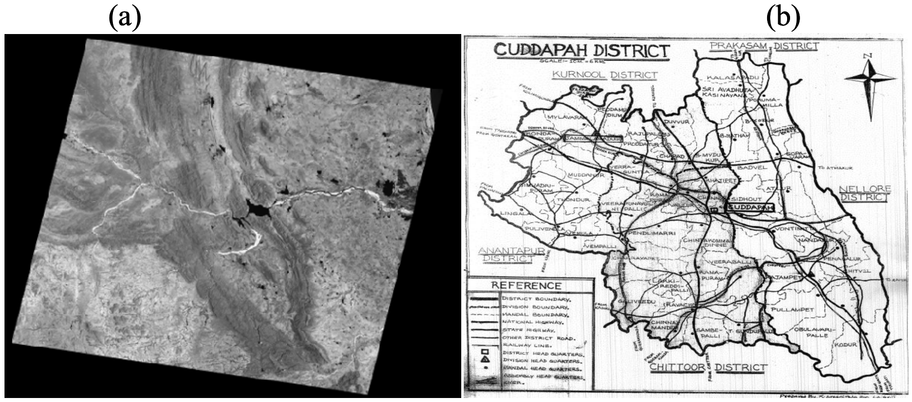


(a) (b)

Figure 6.2: Topography and Forest Area of Study area is shown in the Map



(a) (b)



(c) (d)

Figure 6.3: Reference Map of the study: (a) Path Row Coverage of A.P. (b) Path Row boundary (c) Scene of the study area (d) Scanned paper map of Cuddapah District

DATA PREPARATION

One of the methods for change detection using satellite images is to compare the results of classified images. The advantage of the classified-map comparison method is that not only the location but also the nature and type of the changes are determined in the study area. In other words, it supports to define what landuse has been changed to what other. In this method, first, the images of different times are classified according to the purpose of change detection. Afterward, by overlaying these classified images with a proper overlay condition, the location and amount of these changes that are interested is determined. As the goal is to determine the deforestation, the only two classes that are considered are the forest and non-forest.

The main aim is to determine the landuse and land cover changes due to anthropogenic activity by studying the satellite images of different decades, such as 1991, 2001 and 2011, in order to assess its impact on forest and find association among these factors. Such type data analysis referred as temporal analysis. After doing, all these process which are mentioned above, we found that the individual categories show specific kind of Land use or Land Cover features on the ground. And then, we calculated their areas in square meters to compare amongst them. The detailed process and features extracted form the map are depicted in the basepaper -1 tiled "***Construction of Spatial Dataset Using Remotesensing and GIS Using Arcgis***". This project utilized the features that are refrred as deforestation factors in the specified study area. The final features classes that is extracted from the remote sensing images are depicted in the following table.

6.1: Feature classes extracted from remotesensing image

S.NO.	CNT_ POLYGON	NAME1	SUM_SHAPE
1	16215	Agri- Cultivated Land	457351558.14700
2	97406	Barren \ Sandy area	620934695.39700
3	19	Builtup Land	58403415.02390
4	58634	Degraded Forest	833368943.61900
5	73542	Degraded plantations	238318407.87500
6	29112	Dense Forest	612812518.53600
7	2644	Fallow land	50003539.85520
8	171368	Land with scrub	734220090.93800
9	95904	Land without scrub	2149653350.88000
10	1	Mining	4359230.20296
11	25520	Open Forest	768036008.83900
12	70458	Open scrub	2013648218.00000
14	102438	Sandy area	796247854.01800
15	5382	Scrub	269725625.09900
16	1	Subscenecorner	182168964.36200
17	1824	Waterbody/shadow	466253943.45800

6.2 DATA DESIGN

6.2.1 CREATE AN UML MODEL

As discussed in *Building a Geodatabase*, there are three general strategies to creating geodatabases. The first two strategies—migrating existing databases to the geodatabase and using tools in ArcCatalog and ArcToolbox™ to create the schema for your geodatabase design—are discussed in *Building a Geodatabase*.This project will discuss the third strategy: using UML and the CASE tools subsystem of ArcGIS™ to generate the schema for your geodatabase.UML models are created using specialized tools, such as enterprise architecture, then exported to an intermediate format.

Using CASETOOLS for Schema Design and Generation

The general strategy for using UML and CASE tools to design and create your geodatabase involves using UML to define the entire schema for the geodatabase, generating that schema, and then populating the schema with data. The steps for accomplishing this are outlined below:

1. Create your geodatabase design in UML.
2. Export your UML model to XMI or Microsoft Repository.
3. Use the Schema Wizard in ArcCatalog to create the schema in your geodatabase from your UML model.

Once you have generated the schema, you may want to start directly editing that schema to build your database, but typically you will have existing data with which you want to populate that schema.

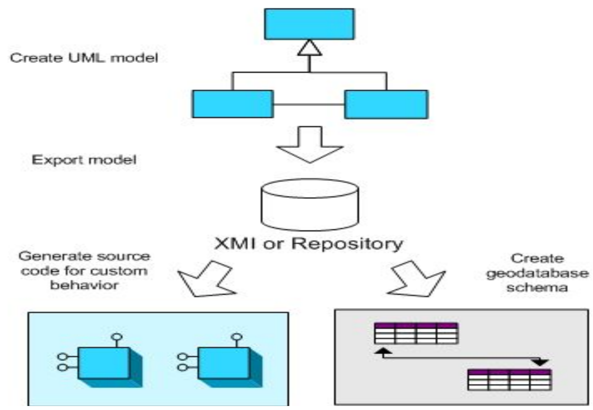


Figure 6.4: Design and development of a geodatabase using UML casetool

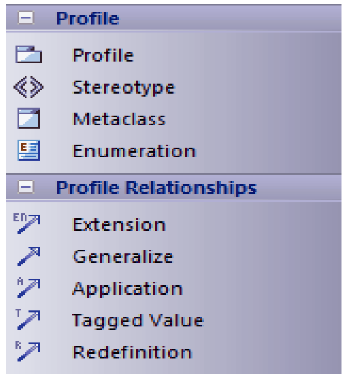
Modeling database structure

Geodatabase elements, such as tables, feature classes, and relationship classes, follow certain rules that dictate where these elements are stored in the geodatabase relative to each other. These aspects of a geodatabase's structure are defined in UML through the use of packages to represent the geodatabase and feature datasets

Structural Elements	Parameterized Behavior	Custom Behavior
Feature datasets Geometric networks Feature classes Relationship classes Fields Subtypes	Elements Domains Connectivity rules Relationship rules	Custom features Feature class extensions Custom interfaces

UML PROFILE GENERATION

1. Open or create a Package diagram.
2. Open the Profile page of the Enterprise Architect UML Toolbox (More tools | Profile).



3. Add stereotype and meta class
4. Define Predefined Tag Types
5. Assign Predefined Tag Types to Stereotypes
6. Use the Tagged Value Connector
7. Define Stereotype Tagged Values
8. Define Stereotype Constraints
9. Add Enumeration Elements
10. Add Shape Scripts
11. Set Default Appearance
12. Export a UML Profile

The following schreenshots describe step – by - step illustration of the profile creation procedure as specified in the previous page.

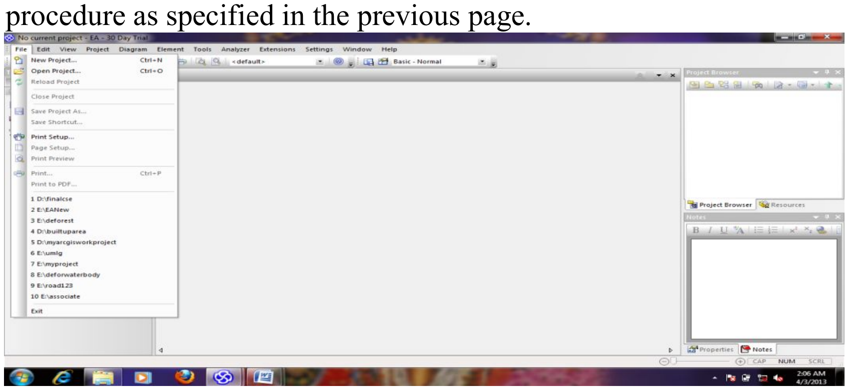


Figure 6.5: Creation of package

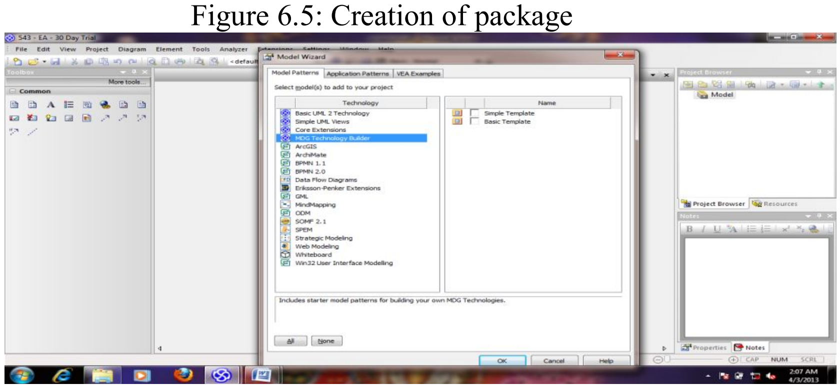


Figure 6.6: Selecting model wizard

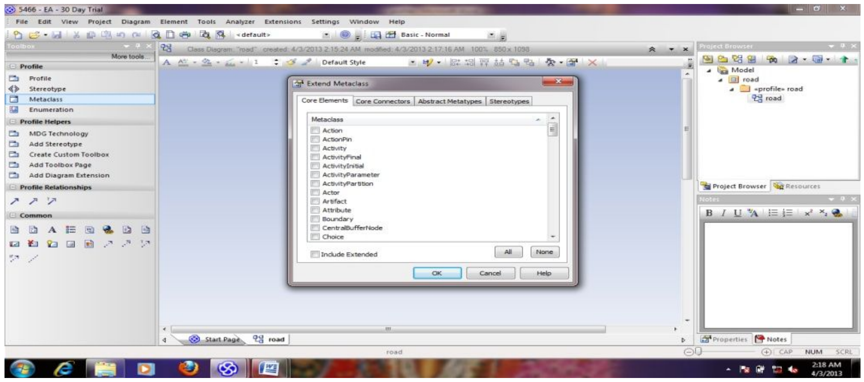


Figure 6.7: Extend metaclass

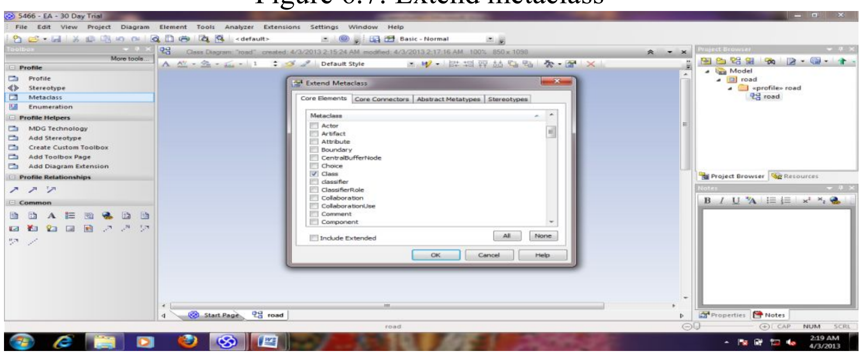


Figure 6.8: Extend metaclass properties

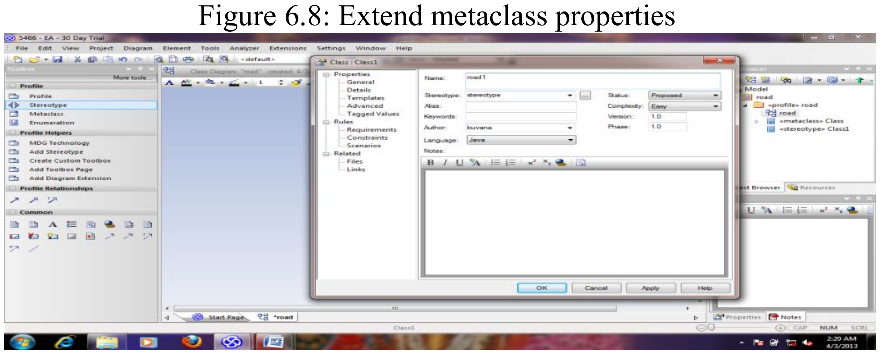


Figure 6.9: Class creation

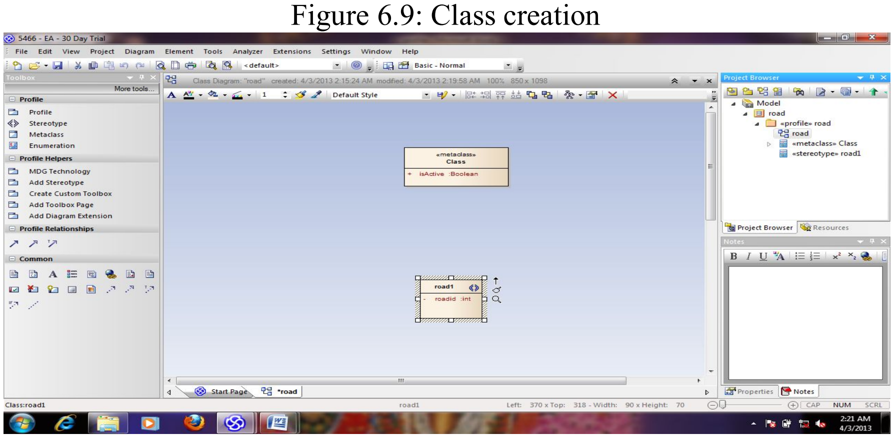


Figure 6.10: Creation of child class

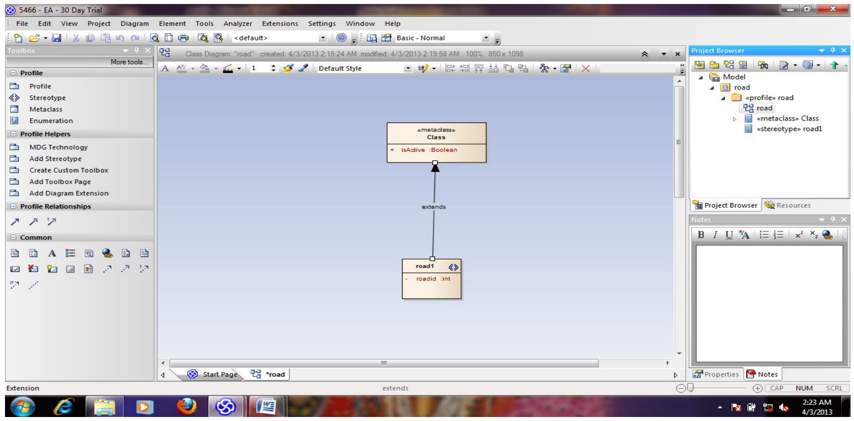


Figure 6.11: Creation of extends relationship

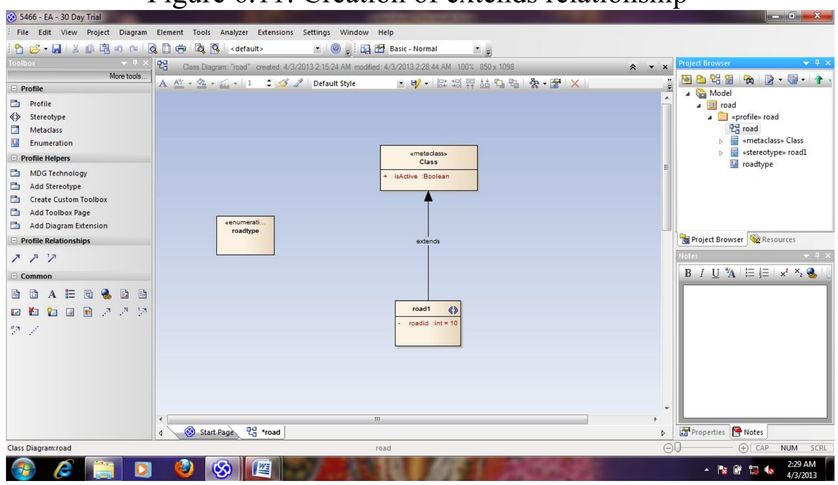


Figure 6.12: Creation of subclass

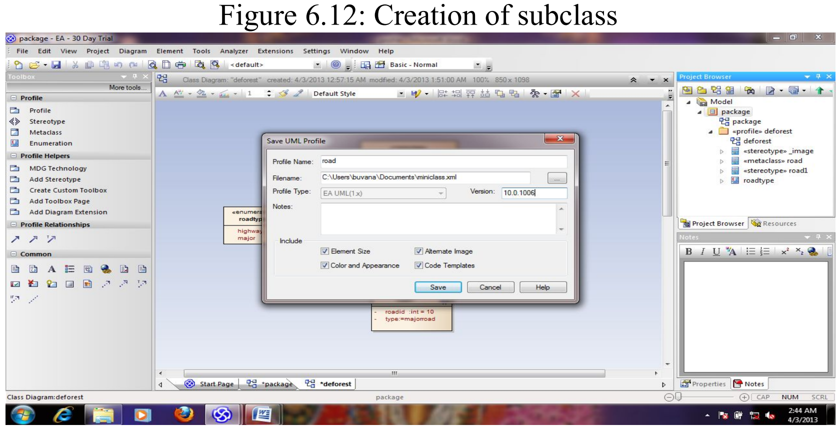


Figure 6.13: Saving UML profile

Use CASE tools and UML to create a geodatabase schema

One strategy that is used for creating a geodatabase is to employ UML to design the schema and the CASE tools subsystem of ArcGIS to generate feature datasets, feature classes, tables, and other items.

Steps

1. With enterprise architecture design a geodatabase in UML and export it to an XML Metadata Interchange (XMI) file or Microsoft Repository.

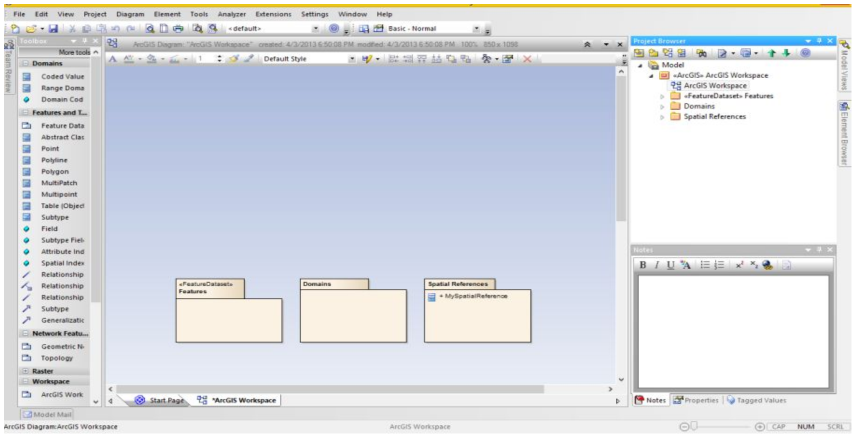


Figure 6.14: Creation of Arcgis package

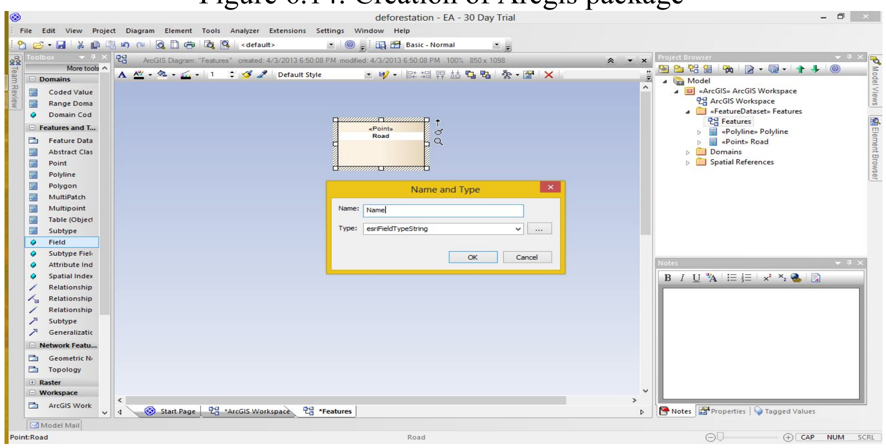


Figure 6.15: Creation of Class

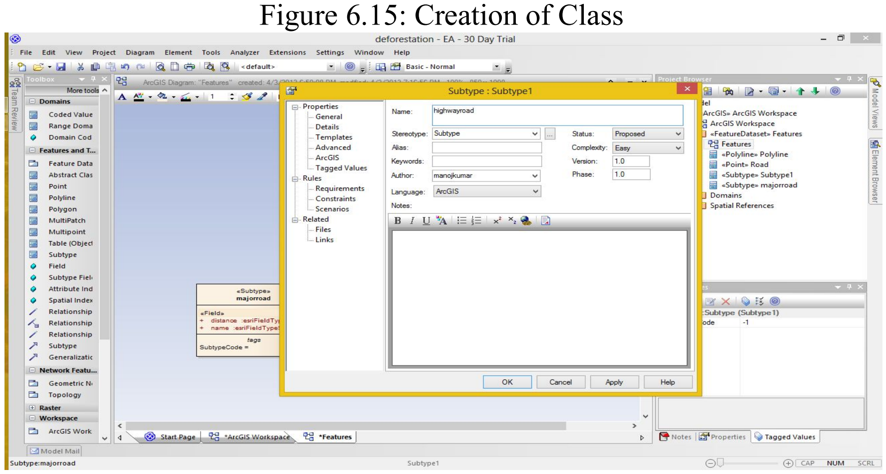


Figure 6.16: Creation of subtype

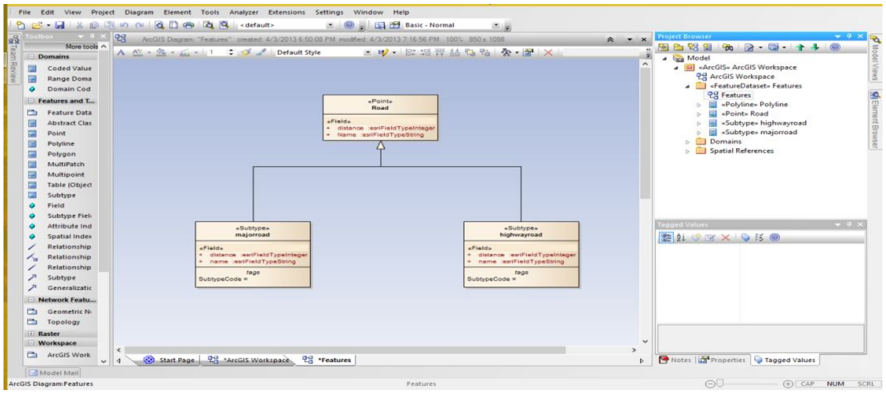


Figure 6.17: Model created

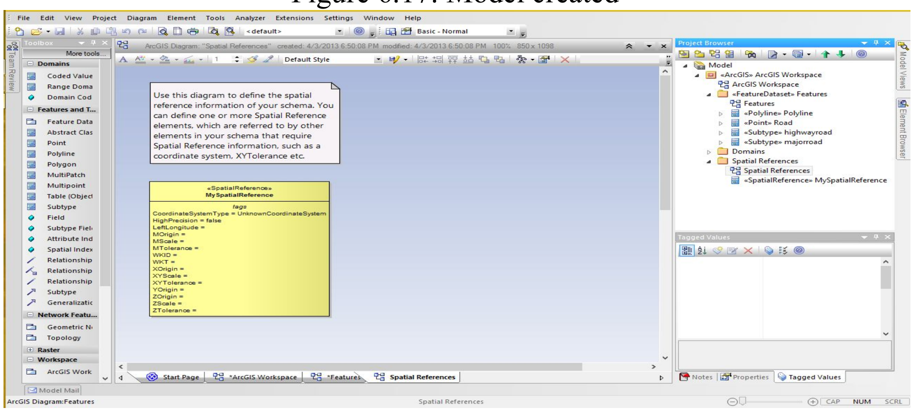


Figure 6.18: Setting the spatial reference

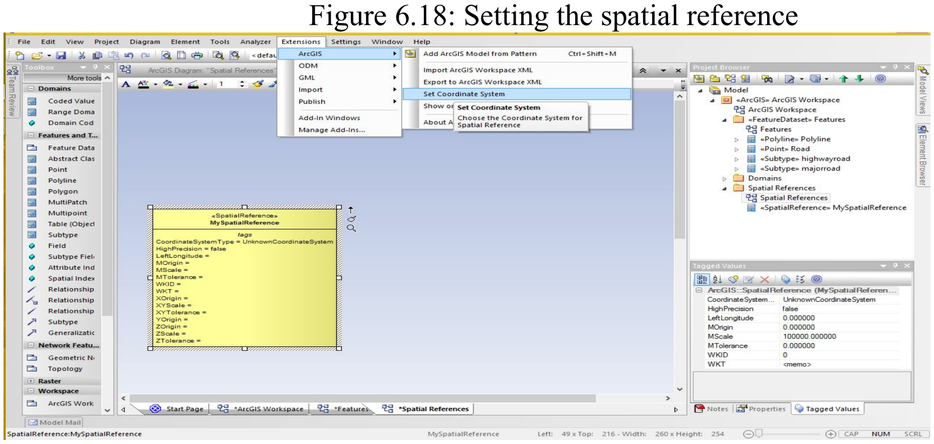


Figure 6.19: Setting coordinate values

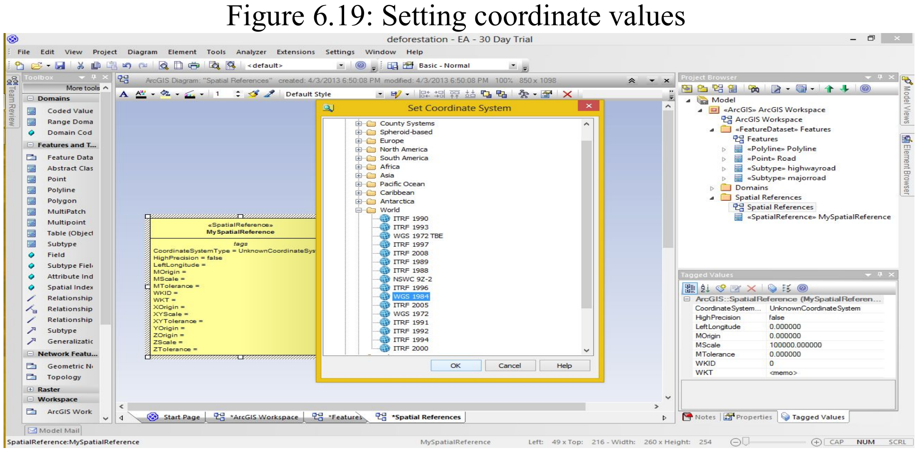


Figure 6.20.Selecting the coordinate system

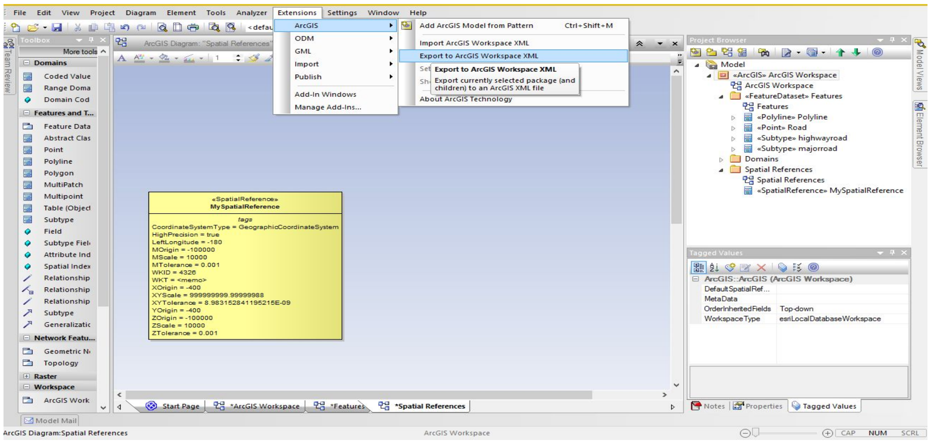


Figure 6.21: Exporting ArgisWorkspace into XMI

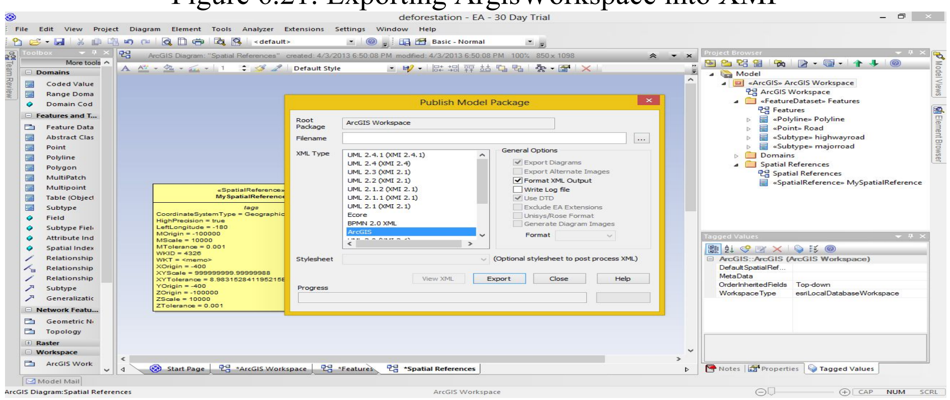


Figure 6.22: Publish model package

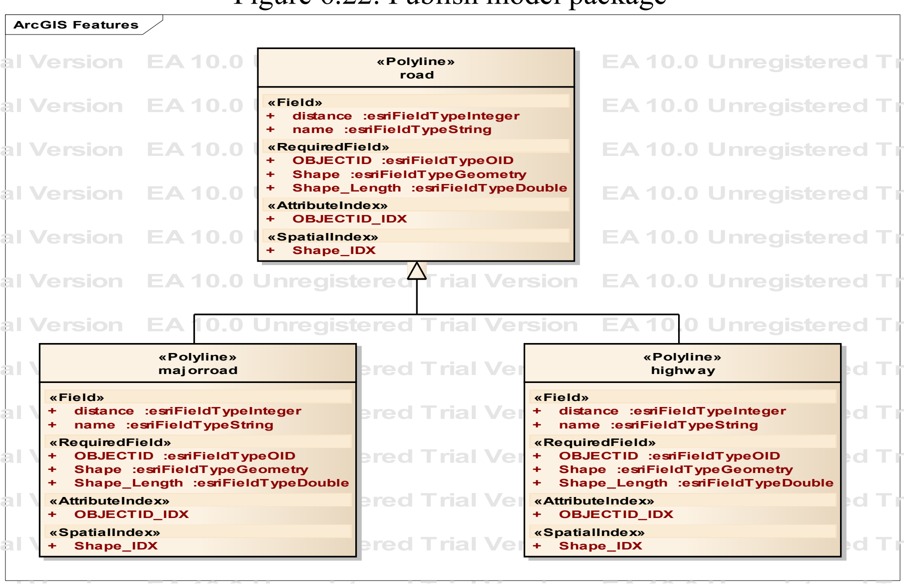


Figure 6.23: Datamodel for road feature

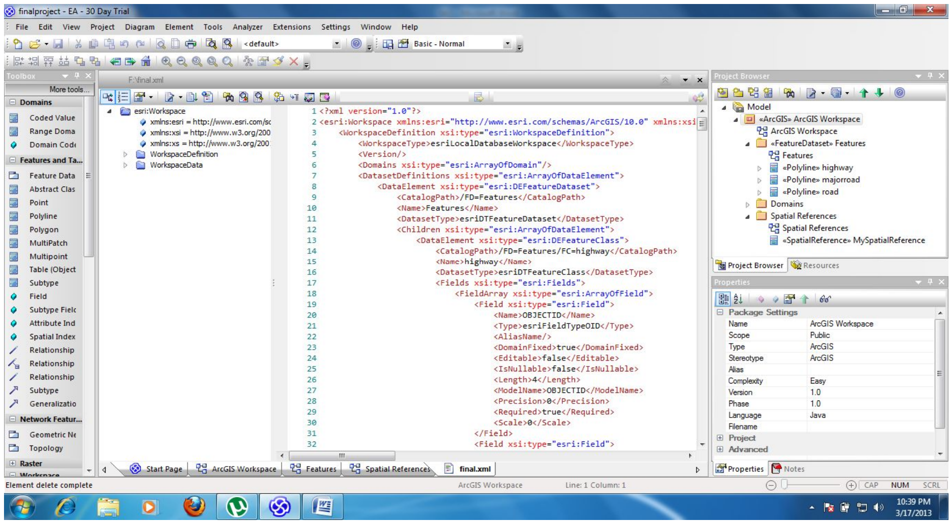


Figure 6.24: XML file generation

2. Add the Schema wizard to ArcCatalog.

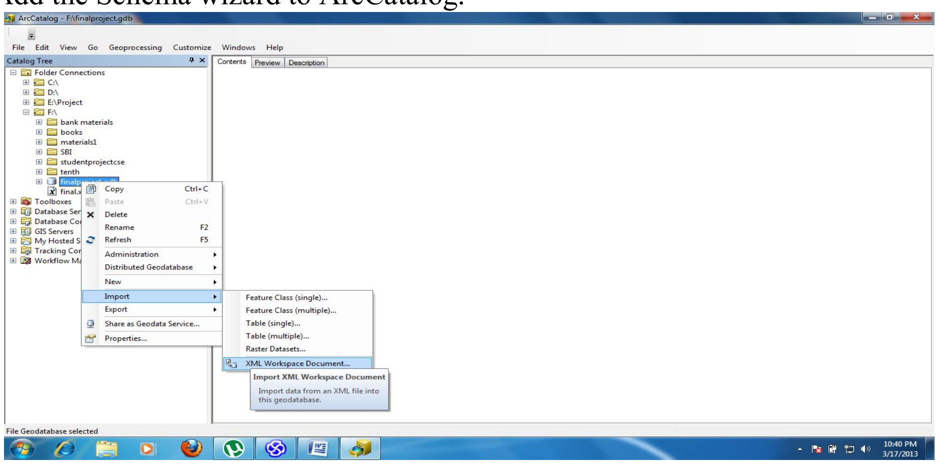


Figure 6.25: Impoting XML workspace document

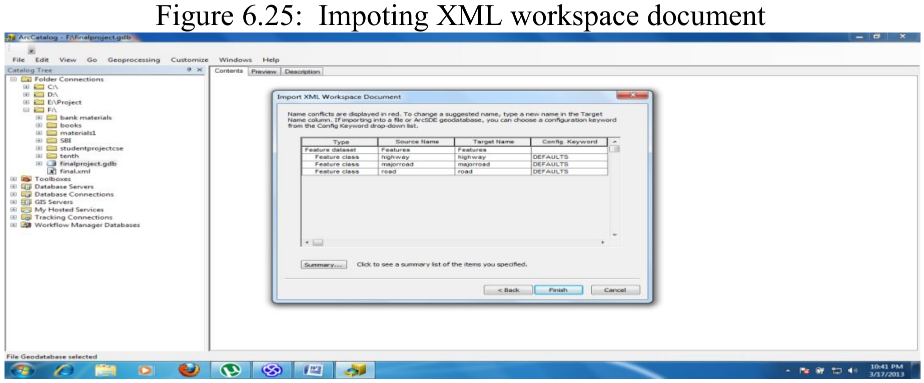


Figure 6.26: Description of fields

3. Generate a geodatabase schema from the XMI file or Microsoft Repository with the Schema wizard.

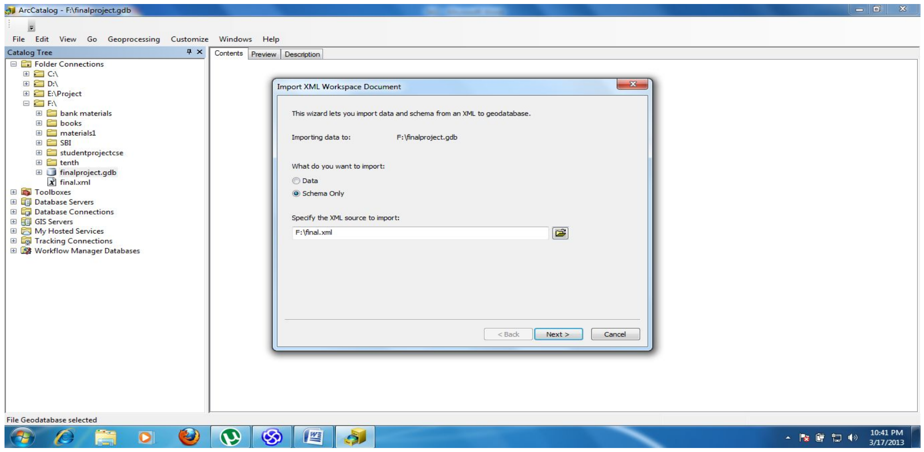


Figure 6.27: Importing an XML File

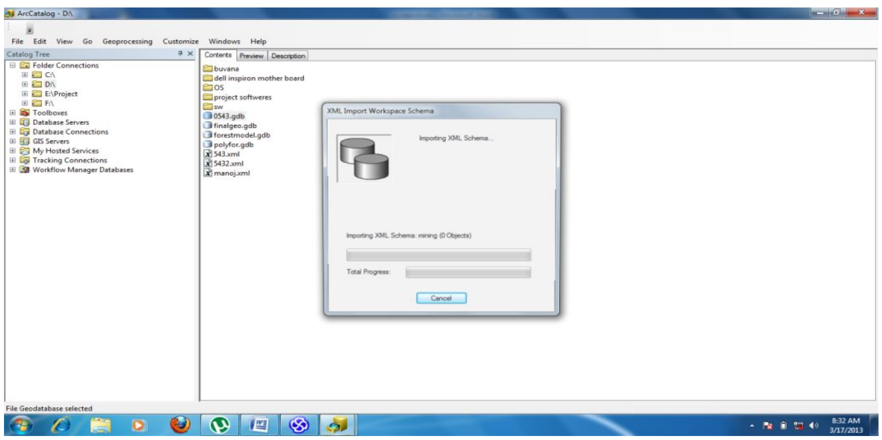


Figure 6.28: Geodatabase creation

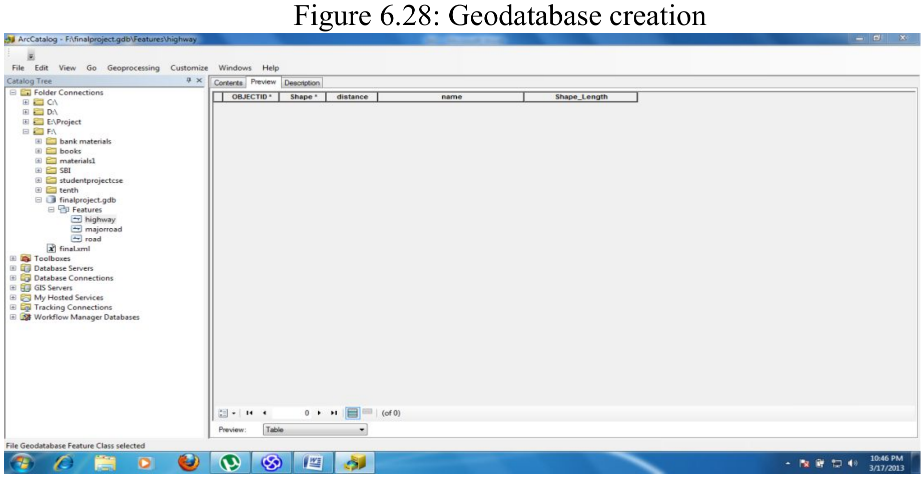


Figure 6.29: Schema generation

Once you have generated the schema, you can modify it with tools in ArcCatalog if needed. Once the schema is ready, you can load data into it. Like wise we have created schemas for features such as road, forest, builtup, cultivation, mining and wasteland which are depicted in the implmentatation part of this project.

7. IMPLEMENTATION

The model provides, for system implementation, the classes VECTOR REPRESENTATION and RASTER REPRESENTATION and enables the association of both representations to the same information layer shows the relation between the conceptual and implementation levels. Note that the user will mostly deal with conceptual level classes, whereas the system developers will use the implementation level classes.

WATERBODY

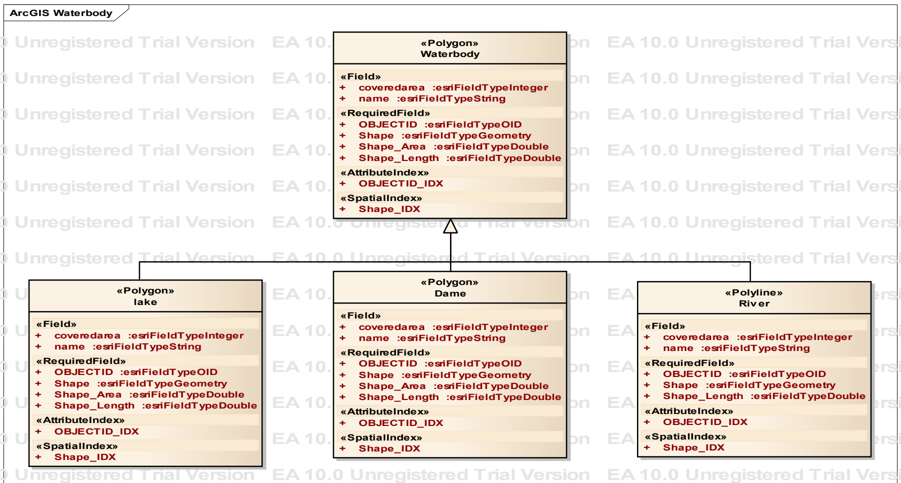


Figure 7.1: Datamodel of feature: Waterbody

FOREST

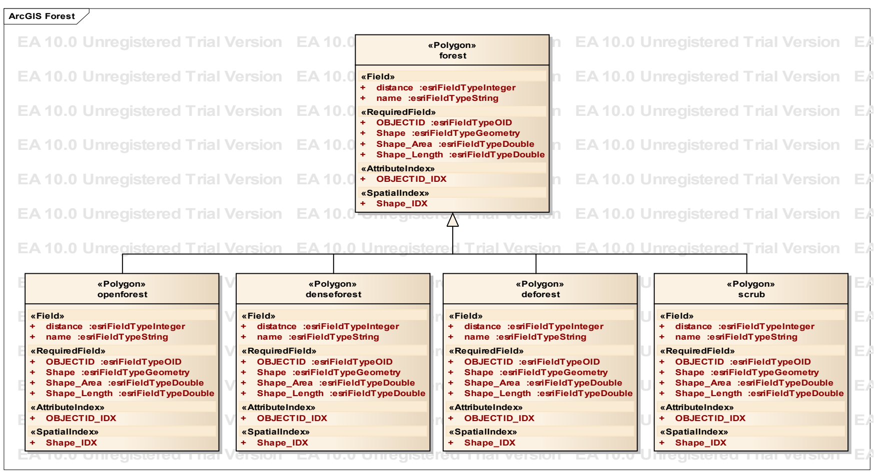


Figure 7.2: Datamodel for forest

MINING

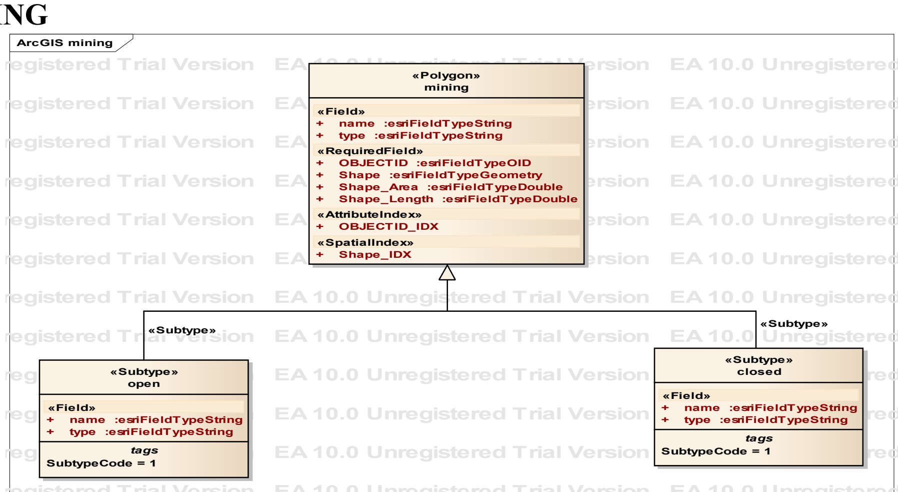


Figure 7.3: Datamodel for mining

CULTIVATION

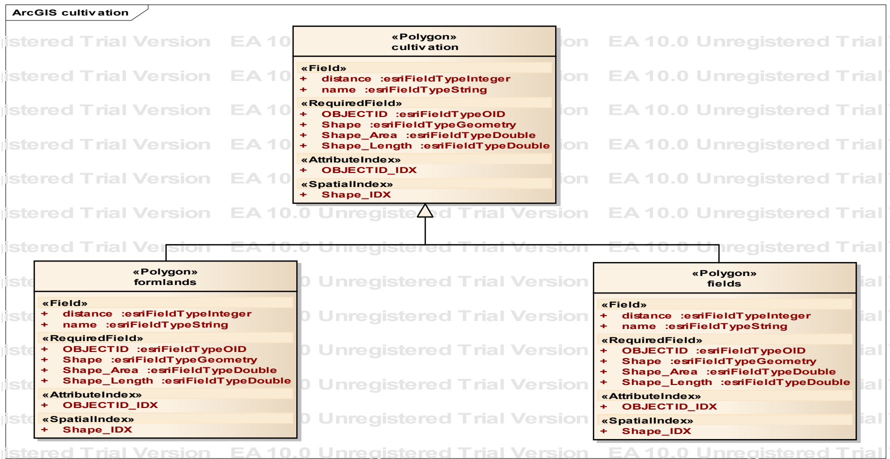


Figure 7.4: Datamodel for cultivation

WASTELAND

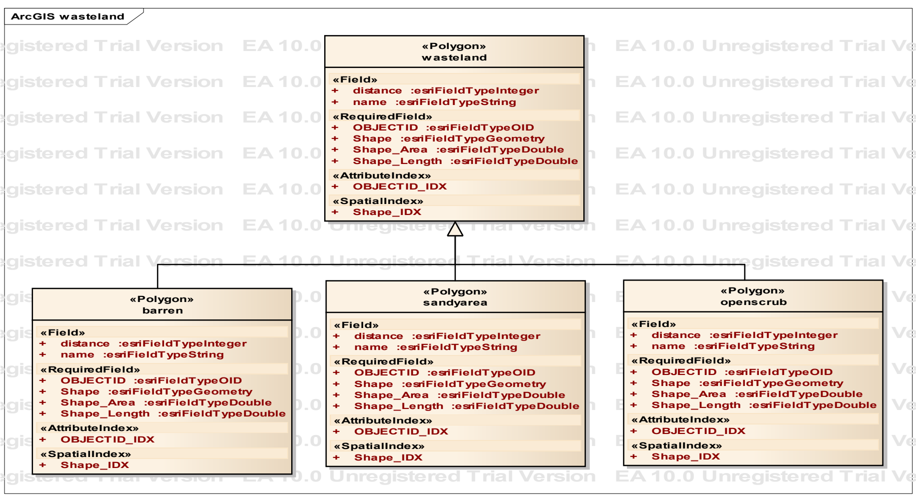


Figure 7.5: Datamodel for wasteland

BUILTUP

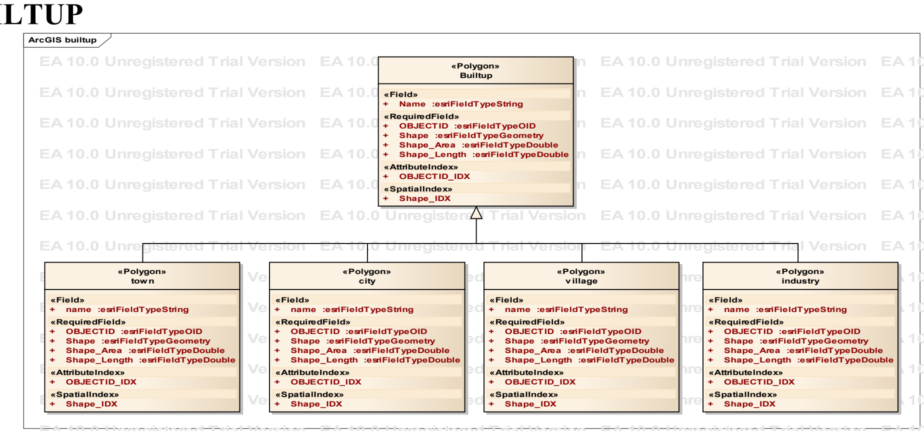


Figure7.6: Datamodel for builtup

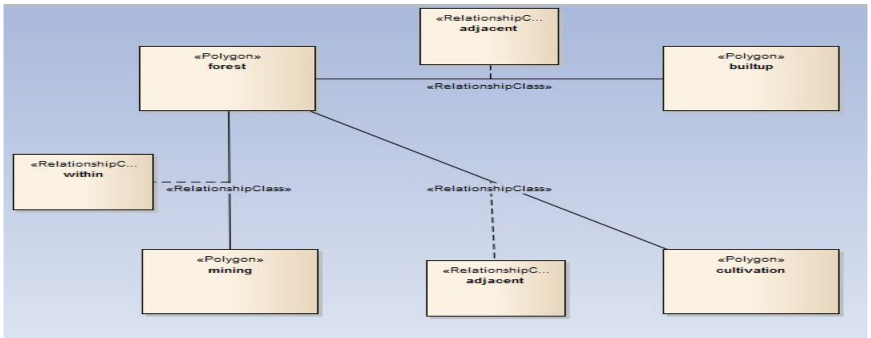


Figure 7.7:Features with relationship classes

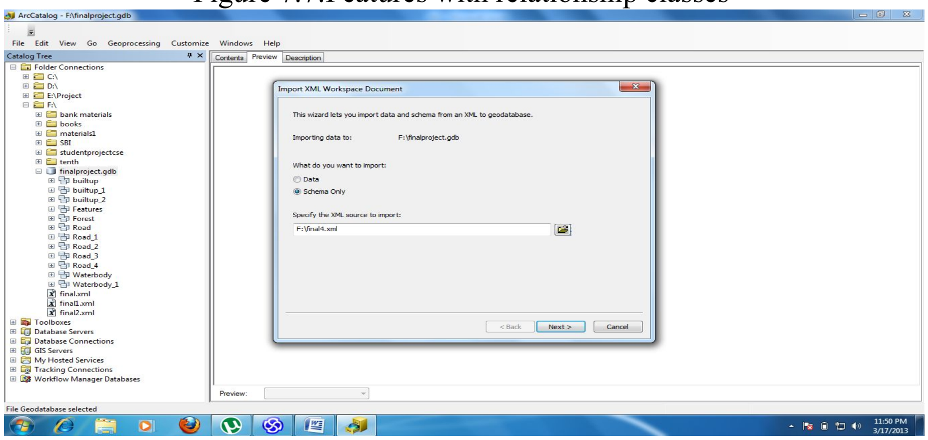


Figure 7.8: Importing a xml file

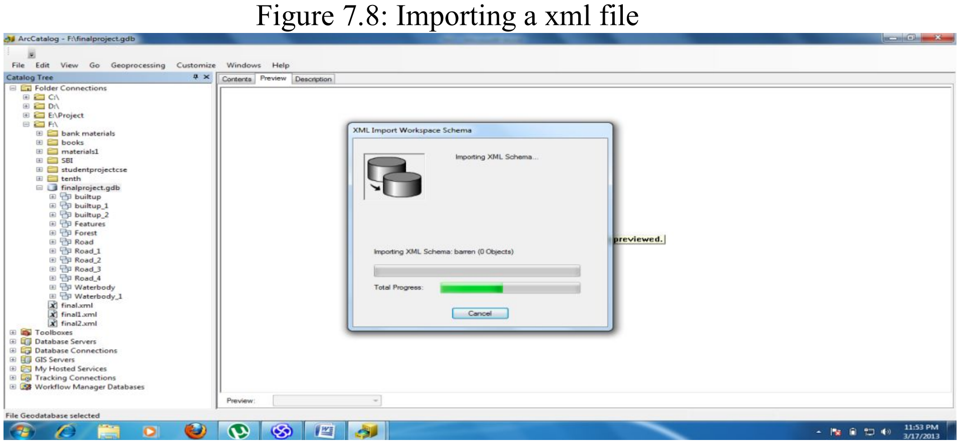


Figure 7.9: Geodatabase creation

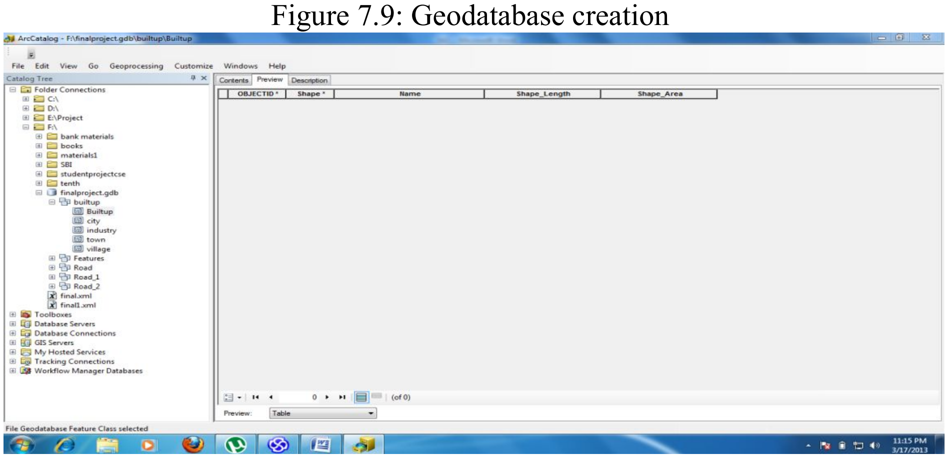


Figure 7.10: Schema generation

7.2 CONSTRUCTION OF SPATIOTEMPORAL DATABASE USING GIS PROFILE

A well-known models include the Space-Time composite model that fragments a base map into smaller units with their own history as it undergoes change, a time based method that uses event chains to record the evolution of thematic data for a given geographic area over time, and a three domain model that represents semantics, space and time as separate, interlinked domains to describe geographic processes and phenomena [Yua96]. Instead, modelling solutions concentrate on capturing change and movement in order to facilitate the answering of certain types of queries.

In this project the UML profile based models are created for various features like Road, Forest, Waterbody, Builtup, Cultivation, Mining and wasteland and the XML code is generated which are stored in XMI. Then using ArcGIS support these code is converted into schemas and finally the schema is populated with data that is used in the study of deforestation factors using GIS and Remote Sensing. The final outcome of the model to database is physically implemented and few tables are also presented here.

Table 7.1: Predicate Count of Adjacent_To Degraded Polygons for the Year 1991and 2001

Attributes of Overall1991_adjcnt2degrdd

OID	Name	Cnt_Name
0	Agri-cultivated land	2029
1	Barren Land	15410
2	Built-up Land	6
3	Degraded Forest	45846
4	Degraded plantation	45932
5	Dense Forest	1637
6	Dense scrub	6447
7	Fallow Land	8132
8	Land with scrub	7977
9	Land without scrub	12176
10	Open Forest	24959
11	Open Scrub	25465
12	River Sand	23
13	Sandy area	435
14	Subscenecorner	1
15	Waterbody	132

Attributes of Adjcnt2degrdd_overall2001

OID	Name	Cnt_Name
0	Agri- Cultivated land	1715
1	Built-up Land	3
2	Degraded Forest	84349
3	Degraded Plantation	43898
4	Dense Forest	2484
5	Dense Scrub	46923
6	Fallow Land	7732
7	Land with scrub	21397
8	Land without scrub	27748
9	MIning	1
10	Open Forest	16037
11	Open Scrub	39362
12	Riverine sandy area	178
13	Sandy area	561
14	Waterbody	92

Table 7.2: Predicate Count for Roadbufferintersect and Roadbufferwithin for the Year 2001

Attributes of fnl2011_rdbfrintrsctSUM

OID	name1	Cnt_name1
0	Agri- Cultivated Land	3500
1	Barren \ Sandy area	10610
2	Builtup Land	11
3	Degraded Forest	7142
4	Degraded plantations	18301
5	Dense Forest	3255
6	Fallow land / Dry Cultivated	533
7	Land with scrub	32991
8	Land without scrub	17387
9	Mining	1
10	Open Forest	3010
11	Open scrub	11041
12	Riversand	509
13	Sandy area	19369
14	scrub	549
15	Waterbody/shadow	222

Attributes of Fnlclsfd2001_withnRdbfr5km

OID	Name	Cnt_Name
0	Agri- Cultivated land	2632
1	Built-up Land	29
2	Degraded Forest	8708
3	Degraded Plantation	19562
4	Dense Forest	652
5	Dense Scrub	7696
6	Fallow Land	18652
7	Land with scrub	18524
8	Land without scrub	28204
9	MIning	1
10	Open Forest	2844
11	Open Scrub	5540
12	Riverine sandy area	904
13	Sandy area	4090
14	Waterbody	50

8. TESTING

Because of the evolutionary nature of these models begin as relatively informal representations of system requirements and evolve into detailed models of classes, class relationships system design and allocation. At each stage the models can be tested in an attempt to uncover errors prior to their propogation to next iteration. Analysis and design models cannot be tested in conventional sense because they cannot be executed.

CORRECTNESS OF OOA AND OOD MODELS

During analysisand design you assess semantic correctness based on models conformance to real world problem domain. If the model accurately reflects the real world that it is semantically correct.

CONSISTENCY OF OBJECT ORIENTED MODELS

It can be judged by considering the relationships among entitites in the model. To assess consistency the following methods are used in this project.

Semantics Checker

The CASE tools expect UML models to be created following a set of modeling rules. The semantics checker can be used to verify that a model stored in the Microsoft Repository or XMI has been correctly defined. It will produce a report with the list of errors encountered in the model.

Object Constraint Language

A UML diagram, such as a class diagram, is typically not refined enough to provide all the relevant aspects of a specification. There is, among other things, a need to describe additional constraints about the objects in the model. OCL is a formal language that remains easy to read and write. It has been developed as a business modeling language within the IBM_Insurance division. OCL is a pure expression language. When an OCL expression is evaluated, it simply returns a value. It cannot change anything in the model.

As a specification language, all implementation issues are out of scope and cannot be expressed in OCL. The evaluation of an OCL expression is instantaneous. This means that the states of objects in a model cannot change during evaluation. OCL can be used for a number of different purposes:

- To specify invariants on classes and types in the class model
- To specify type invariant for Stereotypes
- As a navigation language

Within the UML Semantics chapter, OCL is used in the well formedness rules as invariants on the metaclasses in the profile definition.

OGC

The OGC Technical Committee (TC) has developed architecture in support of its vision of geospatial technology and data interoperability called the OpenGIS Abstract Specification. The OpenGIS Specification, specifically, serves as the technical basis for the Technology Development Process which is realized according to a plan and schedule developed by the Technical Committee. The fundamental unit of geospatial information is called a *feature*. Features may be defined recursively, so there can be considerable variation in feature granularity. Digital geospatial information is geospatial information that has been encoded into a digital form. There are many different ways to create digital representations of geospatial information. This richness of alternatives is more a curse than a blessing since it has created the confusing and apparently chaotic variety of Geographic Information System (GIS) data structures and formats now confronting GIS users. In response to this chaos, an organization has emerged centered on providing technology to bring order, and thus interoperability, to digital geospatial information. OGC exists, in part, to provide unambiguous models of real world phenomena: features, events, and relationships. The OGC is developing technology that addresses common "behavior" of digital geospatial information containers.

OGC Reference Model

The OGC Reference Model (ORM) describes the OGC Standards Baseline focusing on relationships between the baseline documents. The OGC Standards Baseline (SB) consists of the approved OGC Abstract and Implementation Standards (Interface, Encoding, Profile, and Application Schema – normative documents) and OGC Best Practice documents (informative documents).

OGC Feature Classes

OpenGIS feature type is specified by its property set. A property set is a list of property/value pairs that is applied to all features of the corresponding type. The type specifies the list of properties that distinguish the feature, as specified by the Attribute Schema. A feature is the space it occupies, and this is modeled by an OpenGIS WKS. Every feature with extent has a property named geometry.

OGC Relationship

Entities in the real world do not exist in isolation. Typically an entity in the real world is related to other real-world entities in a variety of ways.

Relationship Types - Every *relationship* is an instance of a particular *relationship type*. The relationship type determines the various aspects of the relationship described below.

Degree - The relationship type defines the *degree* of the relationship. The degree is the number of different Roles in a relationship.

Roles - A relationship relates a number of features. Features participating in relationships may perform different and distinct functions or *roles* within a relationship. The relationship type is defined by n*Roles types*, where n is the degree of the relationship.

Role Types - The role type is a specification of what roles a feature has and how relationships connect to those Roles. The role type also constrains how many relationships can be reached from a role and whether the ordering of those relationships is important.

· Feature types
· Cardinality
· Ordering

Role Types and Feature Types- Feature types are defined to have zero or more role types and thus define which relationships a feature can participate in. A role type can be defined on more than one feature type.

Roles Types and Cardinality - The role type places a constraint on the number of relationships that can use that role. This is Referred to as its *cardinality*, or sometimes its *multiplicity*. Cardinality is expressed as a subset of the non-negative integers. Common values are one; zero-or-one; zero-or-more; and one-or-more

Role Types and Ordering - If the role type permits more than one relationship, then the role type must indicate if the *ordering* Of relationships is meaningful.

Directionality - Relationships are *multidirectional*. When features are related using a relationship, the relationship can in principle be navigated from any role to any other role.

9. CONCLUSIONS

In the project we outlined the development of a geodatabase for deforestation factors from the phase of logical modeling performed using the UML and CASE tools to the implementation of a developmental database within the ArcGIS development environment. A systemic approach is suggested for development of complex geodatabases: development of a conceptual model, followed by logical data modeling, and finally creation of a physical model, upon which the database is ready for implementation. Implementation of the STDBGIS database model has been illustrated by the example of the analyzing deforestation factors using GIS. It has been demonstrated how, by means of a visual representation, database users (managers, mining engineers, geologists, ...) can have a clear picture of the entire system, and at the same time easily access alphanumeric data.

FUTURE ENHANCEMENT

The outlined solution is only the first step in creating an integral GIS system for a natural resource forest. Hence, further research in this area will focus on extension of the system .with thematic classes related to population and other factors, integration with deposit modeling tools, and 3D extension. In the era of web publication of data in all areas, we plan to create a web GIS portal with contents from the database.

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