Integration of remote sensing and GIS to produce Land use and Land cover maps for Kerbala city

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Abstract

IKONOS satellite image acquired at 1999 with resolution (1)m was used to produce land use and land cover maps for Kerbala city , using Arc-view (version 3.3) program which is one of the GIS programs . Also Erdas program (version 8.4) was used to enhance and uncompress used image to become visually more obvious .

Basically visual interpretation and ground truths was depended upon to specify land features appear on image , and then to produce main information layers represented by land use and land cover maps , in addition to drainages , roads , and religious locations layers which in turn represent land use layers. All produced layers were supported with updating database includes information related these layers such as feature's names , lengths , areas …etc.

The study used modified Anderson land use classification to produce the final map of the interest area (95.8 km2). The produced maps can be set with any demand scales . The study also certify the importance of the integration between remote sensing technique and GIS , which represent an active tool to get the best results with less efforts , less coasts , less time and better details.

المستخلص

استخدمت مرئية القمر الصناعي (IKONOS) المكتسبة عام 1999 بقدرة تمييز مكاني (1) م لإعداد الخرائط الأولية لاستخدامات الأرض وغطائها لمركز محافظة كربلاء بالاستعانة ببرنامج (Arc-view 3.3) وهو احد برامج نظم المعلومات الجغرافية (GIS) . كما استعين ببرنامج ايرداس (ERDAS 8.4) لإجراء بعض المعالجات الرقمية للمرئية المستخدمة ، والتي اقتصرت على تحسين ظهور المعالم الأرضية المختلفة على المرئية ومنها تحويل الصورة من الحالة المضغوطة إلى الحالة الاعتيادية ليزداد وضوحها .

أعتمد التفسير البصري كأساس لتحديد المعالم الأرضية الظاهرة على المرئية المستخدمة وإنتاج طبقات المعلومات الرئيسة والتي تمثلت بطبقتي الغطاء الأرضي واستخدامات الأرض ، إضافة إلى طبقات الأنهار والطرق والمواقع الدينية وهي من معالم استخدامات الارض . وقد أسندت كل من هذه الطبقات (الخرائط) بقاعدة بيانات ضمت أسماء المعالم وأطوالها والمساحات التي تغطيها ، وهي واحدة من التسهيلات التي تقدمها نظم المعلومات الجغرافية من خلال ربط تلك المعالم الظاهرة على المرئية بالحقائق الأرضية ، على إن تلك البيانات قابلة للتطوير والتحديث . وقد استخدم البحث تصنيف اندرسن العالمي المعدل لإنتاج الخارطة النهائية لمركز المحافظة التي غطت مساحة (95,8) كم^2 ، إذ يمكن إخراج هذه الخرائط بالمقاييس المطلوبة . كما أكدت نتائج البحث على ضرورة اعتماد مثل هذا التكامل في دراسات استخدام الأرض والغطاء الأرضي كونه يمثل أداة فاعلة وسريعة للحصول على أفضل النتائج بأقل الأوقات والتكاليف مع تباين الحاجة لجمع الحقائق الأرضية بتباين هدف الدراسة.

Introduction: -

Land cover term is used to represent natural features cover the ground such as plants, grass , and rivers. While land use term is used to specify the kind and nature of land used by human such as building , houses , roads , bridges , etc. .Also land use term is defined as the operation of converting natural environmental system to social environmental system through complicated artificial procedures (Zhon and Hai,1999) . Accordingly it is difficult to differentiate between these two terms, because of large interference between them .Which in turn depends on the nature of the area under study. For example space images for housing coniferous forest can detect coniferous plants only (land cover) but they can't detect houses beneath (land use) . On the contrary , most of the

residential area contain green areas which can't be detected due to it's small area or may covering by high buildings (Pozzi,2001).

Visual interpretation used in this study to locate land features on the used image and to produce the main two information layers represented by land use and land cover, in addition to rivers, roads , and religious locations layers (maps). All produced layers were supported by updating database includes mostly feature's names ,lengths ,and areas . In addition to that GIS (geographic information system) has the ability to make an active link between feature on the image (or map) and related information in the associated database .This research used Anderson modified classification (Anderson etal,2001) to produce the final map of Kerbala city that cover 95.8 km^2 ,and the produced map can be set at any demand scale.

The First aim of this study is to produce base map for Kerbala city depending the integration of space data with GIS which also help to build a complementary database for kerbela'a city (fig -1) , and such map may be useful and dependable in designing future plans for the city.

An interactive between land use and land cover is important in define future studies for different domains (such as civilian planning , agriculture planning , dissertation…etc.) .Rivers and roads have their own signatures on human habitation and so on future land use and land development (Bektas and Goksd,2006).**The study also aimed to define and classify human activities using Anderson modified classification (Anderson et.al,2001).** Area for each class also calculated with the aid of Arcview program .

All recent studies certify the active tool of integration between information acquired from land and space with the aid of GIS   (Aldakheel and al-Hussaini,2005).

This study was depending mainly on space image required by IKONOS satellite at 1999 with visual band and with spatial resolution of (1m) (plate-1).

Geographic informatiom system(GIS):-

The new age is distinguished by information and technology revolution . One of it's aim is to facilitate the ability of getting huge amount of information about nature and human being using remote sensing techniques with less time and efforts. The difficulties of processing and using large amount of information in different domains were the main causes behind the appearance of new computer system called GIS aid in collecting , storing , and analyzing spatial data , these data can be represent in different manners (chart ,tables ,graph…etc). This system is one of the successful techniques in spatial studies (such as geographic studies   ,civilian planning…etc.), that produce digital database which can be handled automatically . Scientific specializations of using GIS and various applications has been increasd , this leads to appearance of various definitions for this system . Al-azawi (2005) reviewed a wide concept definitions about GIS :

1. Brassel definition :- GIS is information bank that collect and store geographic data electronically , these information analyzed and processed by computer programs to get results in the form of graphs , tables , maps or reports.
2. Cherley definition :- GIS is a technical system to store ,check ,treat , analyze , proceed , and display data with spatial nature or ground related in the form of graphs , maps , tables , reports…etc.
3. Mohammad ali definition :- GIS is an integration system aimed to store, analyze, proceed, and display data that are ground coordinate dependent.

So we can say that GIS is no more than a computer system aimed to store, analyze , and proceed spatial updating data , and can display them in different forms (such as grids , maps , tables , and reports) to aid planners and decision makers in deciding plans (development   , agriculture , dissertation , housing…. etc). For example rivers and roads have their own signatures on human habitation and as well as future land use and land development (Bektas and goksd,2006).

This study also aimed to define human activities and classified them with the area of study using Anderson modified classification (Anderson etal,2001) , and calculate area for each class using Arcview program .

The main functions of GIS are (Al-khuzami , 2000) :-

1. Input data to computer in digital form (either raster or vector).
2. Join data of different sources that stored in computer by their geographic coordinates .
3. Modify, change, and transport data from location (themes) to other locations, with the ability of comparing different themes for the same area, and specifying information by their location.
4. Retrieve and analyze data (such as searching for certain feature using associated database and vise verse) , also make statistical analysis for any defined location within the area of study and calculate areas and distances.
5. Analyze and processed descriptive data, also make spatial classification.
6. GIS has the ability of making queries for database combined with each information layer.
7. Creat 3-d model for nature or human phenomena to facilitate visual perception.
8. Coincide different space images with the maps.
9. Make boundaries around different phenomena.
10. Activate and hide different layers at the same time and display them on demand .

Arcview- version 8.8 was used to analyze data from space image and produce base map , with the ability of using this map with the other GIS program such as Arcinfo. and Mapinfo. .While this program proceed space image as a file in the form of (Gif , Jpeg , Bmp , Mrsid). This study used space image in the form of Mrsid .

Materials and Methods :-

Method can be briefed in the following steps:

1. Data collection:- include :
    - collecting of available maps of the studied area :- We got only an old one represent by praedial map produced by Directorate of Municipality of Kerbala
    - names of street and housing areas:- Familiar names have been used, and GPS was used to check their location and compare them with that on the map . But high resolution of the space image decrease needing for ground truths (i.e for GPS).
    - space image : represented by IKONOS satellite image with spatial resolution of (1)m.
2. Space image processing:
    This has been done with ERDAS program version 8.8 which is one of ESRI products. Image processing restricted in this research by image enhancements which include edge and contrast enhancement. Also ERDAS was used to uncompress image. In addition , this program was used to convert image coordinates from world geographic system(WGS84) to Marcator coordinate (UTM) in order to coincide image with available maps, also to calculate lengths and areas of different features in metric system.
3. Project information acquired from space image and ground truth
    (specially when loosed on image due to it's minute size or covering by
    other features) to draw land use and land cover maps using Arcview
    program.
4. Create updating relational database combined with each information layer by Arcview program.
5. Classify land use features depending Anderson Classification (Anderson et. al.,2001) see fig. 4&6.

Results : Maps were produced for Kerbala city ; each map represent a separated information layer performed by Arcview (fig 2-6), except the final map (fig-7) represents a mixer of all information layers.

Map no.1 : Drainage layer (fig. - 2):-

Firstly we traced Hussainyia and Rashidyia river tracks which appear inside study area , then river branches and drainages were joining to them with correct manner supported by ground truths , because it appear to be separated on the used image .So ground truth is one of the complementary step to draw map from space image.

Also a classification for drainage pattern was made and 4 classes were recognized , then rivers names were projected on the map, and the length of rivers was calculated (fig. -2).

Map no.2 : Roads map(fig. -3):

All roads were delineated (mains and branches, paved and unpaved), and names of the main roads were projected on map in addition to housing area surrounded these roads. This map can represent a base map for the city to use in development planning(fig.-3).

One of the most important facilities presented by GIS is the ability of calculating lengths and areas of the features according to the coordinate system used in the image. So working on this system will substitute most field works but not all.

Map no.3 : Religious locations map(fig. -4):

Most religious locations recognized on image were delineated, in addition to those recognized on land which were not appeared on the image for the reasons mentioned before such as (Makam chef Al-abbass). This location gave codes from 1-20 (table in fig. -4).

Religious locations were represented here by all holy shrines and only some big mosques . So this map can be depended upon as a base map for religious tourist for Kerbala city after projecting other related features such as hotels; restaurants,… etc) , specially that all streets join these features appear on this map.

Map no.4: Land cover map (fig.-5):

Land cover areas represented mostly by palms and citrus trees orchards which restricted to the north-east corner of the study area and constricted by Kerbala-Babylon and Kerbala-Baghdad roads (fig.-5).

The total area of land cover within the study area was about (16.5 km^2 or 16475282 m^2) including some swamps .

Although used image was of high spatial resolution but didn't detect housing area covered by palms and citrus trees over all land cover zone, so this zone representing area of interference between land cover and land use and that what we were mentioned at introduction .**So ground surveys or what called ground truths are the best solution for this type of interference, specially when we use visual band only.**

Map no.5 : Land use map(fig.-6):

This study depends on Anderson (Anderson et al. , 2001) to classify land use areas, and five classes were recognized (fig.-6):

1. Holy shrines and religious locations: includes small area relative to other .
2. Residental : it cover most of the study area of about (17.4) km^2 or (17394791 m^2).
3. Residential-commercial area : represented area associated between markets and housing and it was restricted mainly in the zone surrounded the holy shrine of Imam Hussain and Imam Abbass and streets lead to their shrines , and it's area of about (5.7) km^2.
4. Industrial area : the study didn't specify all the industrial areas but restricted to main ones such as:
   1- Al-Hay al Synaee.

2- Caning and Yogurts Factory.
3- Palm Caning Factory.
4- Yashmaq Textile Factory.

Table -1 shows the area for each one , where the total area of this zone was 0.76 km^2.
5. Quarries : appear at separate locations over all the area of the study, but concentrate at western side of Kerbala- Najef road , and they cover very small area.

Industrial locations		
Name	Area (km^2)	Name on final map
Al_Hey al_Synaee	0.062	Al_Hey Al_Synaee
Caning and Yogurts Factory	0.09	Taleeb and Alban
Al_Yashmaq Textile Factory	0.00049	Al_Yashmaq Factory
Total area	0.76049	

Table-1: shows industrial location recognized on land use map (fig-6)

Map no.6 : Final map (fig-7):

It represents the final resultant that collect all previous maps in one. This map can be useful and dependable in all preliminary studies for investment and development plans ,because nearly all important ground features can be recognized on it .

Conclusions

1. The study certify the necessity of integration between remote sensing data and GIS. This necessity will increase with increasing in the area of study. Because this technique represent fast , accurate, and cheap method of producing land use and land cover maps with low efforts, specially for wide area and regional studies to support reconstruction , investment , and development plans.
2. using this technique will reduce field work to the lowest level . But need for field works (ground truths) will vary according to the aim of the study .
3. The high spatial resolution of the space image has it's effects to reduce field works and make the results more accurate.
4. Ground truths are the best solution for detecting interference between land cover and land use specially when using visual band only.
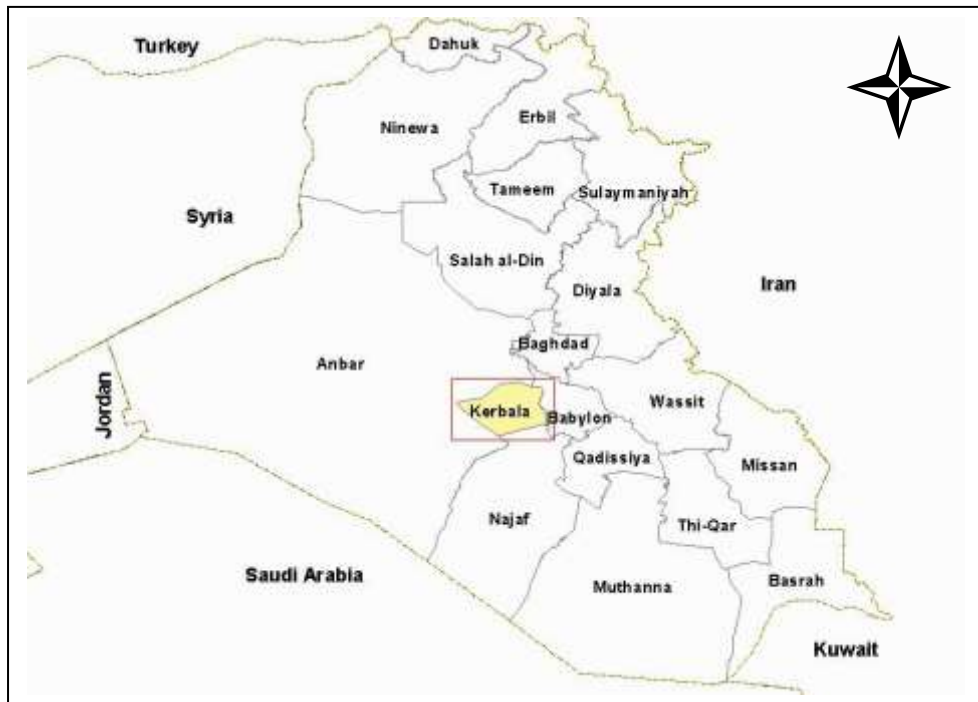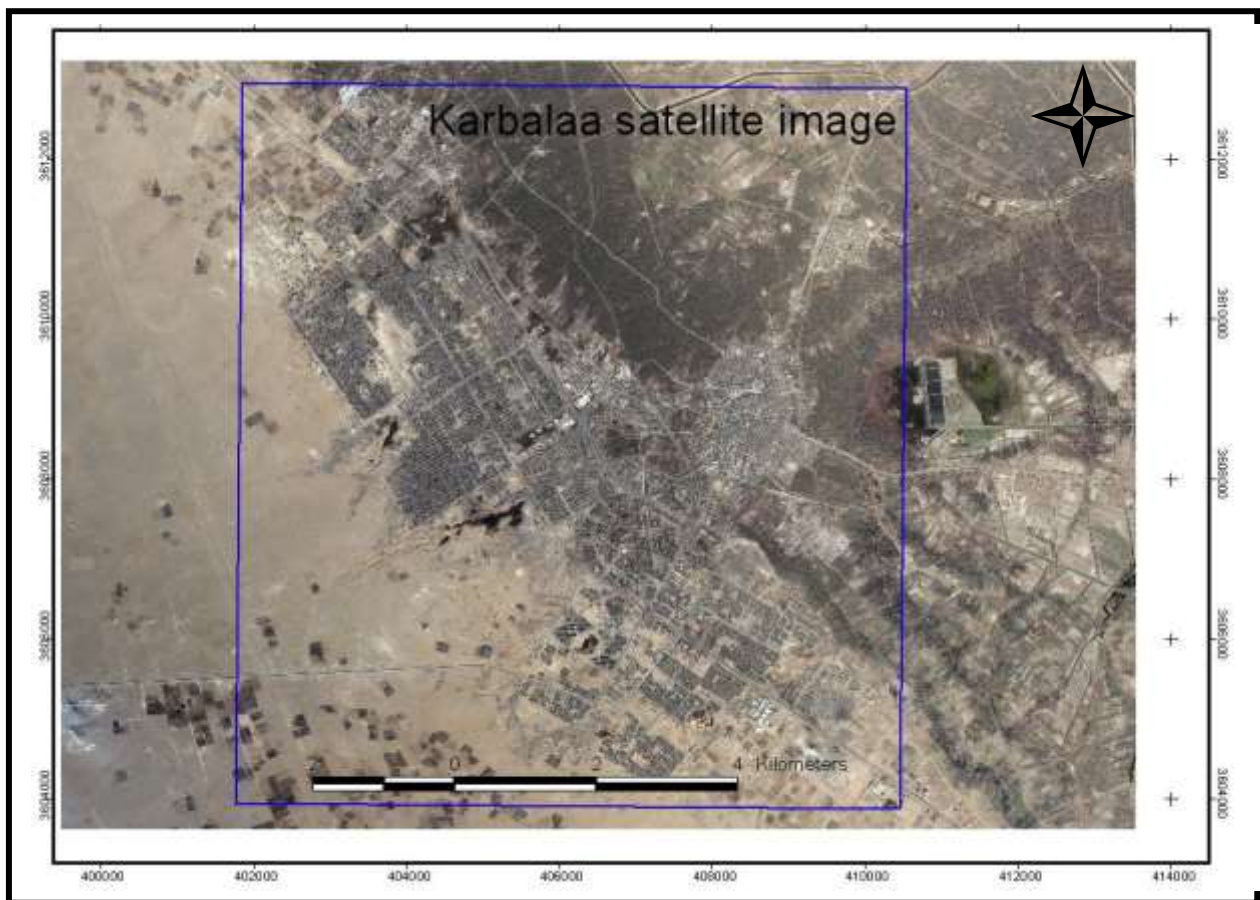
Fig.-1 : Location of the study area
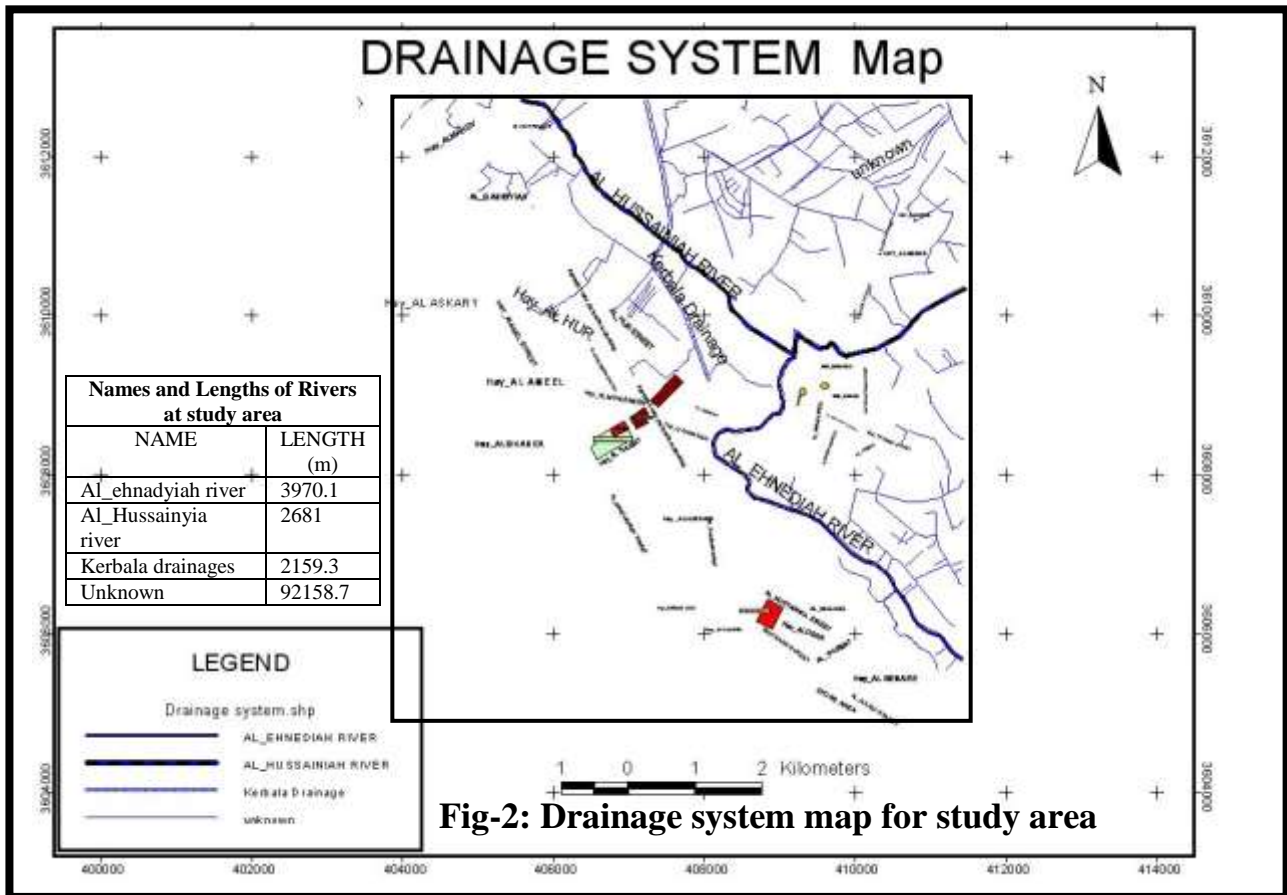

Plate-1: Ikonos satellite image used in the study

DRAINAGE SYSTEM Map

Names and Lengths of Rivers at study area	
NAME	LENGTH (m)
Al_ehnadyiah river	3970.1
Al_Hussainyia river	2681
Kerbala drainages	2159.3
Unknown	92158.7

LEGEND

Drainage system.shp

AL_EHNEDIAH RIVER
AL_HUSSAINIAH RIVER
Kerbala Drainage
unknown

Fig-2: Drainage system map for study area

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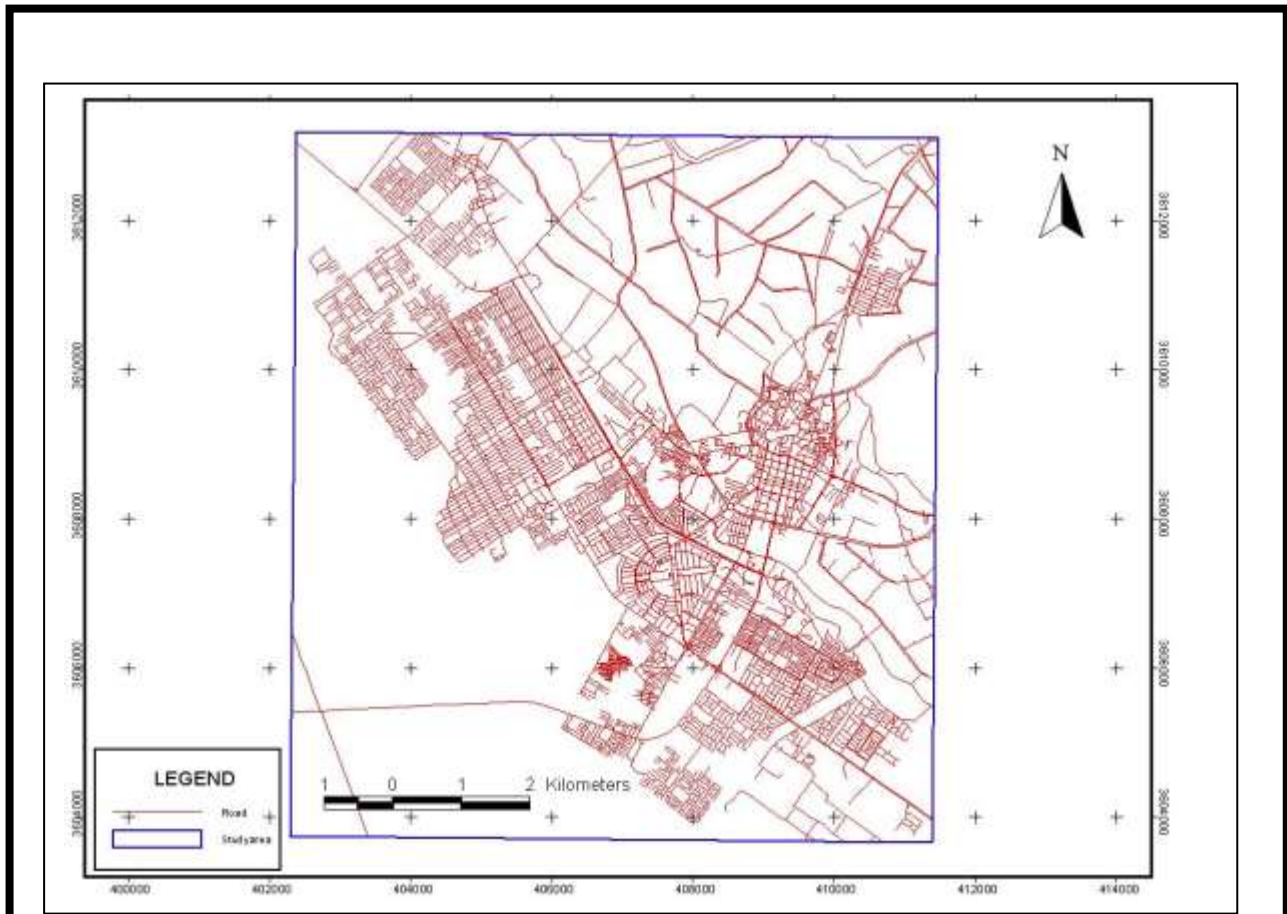
Road
Studyarea

Fig-3 :-Roads map For study area

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Karbala'a Holly shrines Map

Religious location Index			
Al Hur shrine	11	Imam Abbass holy shrine	1
Imam Al Sadik shrine	12	Imam Hussain Holy shrine	2
Ibn Al Hamzza shrine	13	Islam lef Imaikbas	3
Faidh Hussainv Hussainvia	14		4
Al isfehanvia Hussainvia	15	Al Hussain Camp	5
Ibn Fahed holy shrine	16	Imam Al Hassan mosque	6
Al Rusool Al Aathem Hussainvia	17	Awlad Amer mosque	7
Al Zehra'a Hussainvia	18	Sayed Jodah mosque	8
Al mukhaim mosque	19	Tel Azzainabia shrine	9
Al Imam Ali Hussainvia	20	Imam Al Mahdi shrine	10

LEGEND

Road

Hollyshrines

Studyarea

Fig.-4 : Religious locations map for study area

Land cover Map

LEGEND

Drainage system.shp

AL_EHNEDIAH RIVER

AL_HUSSAINIAH RIVER

Kerbala Drainage

unknown

Orcharda
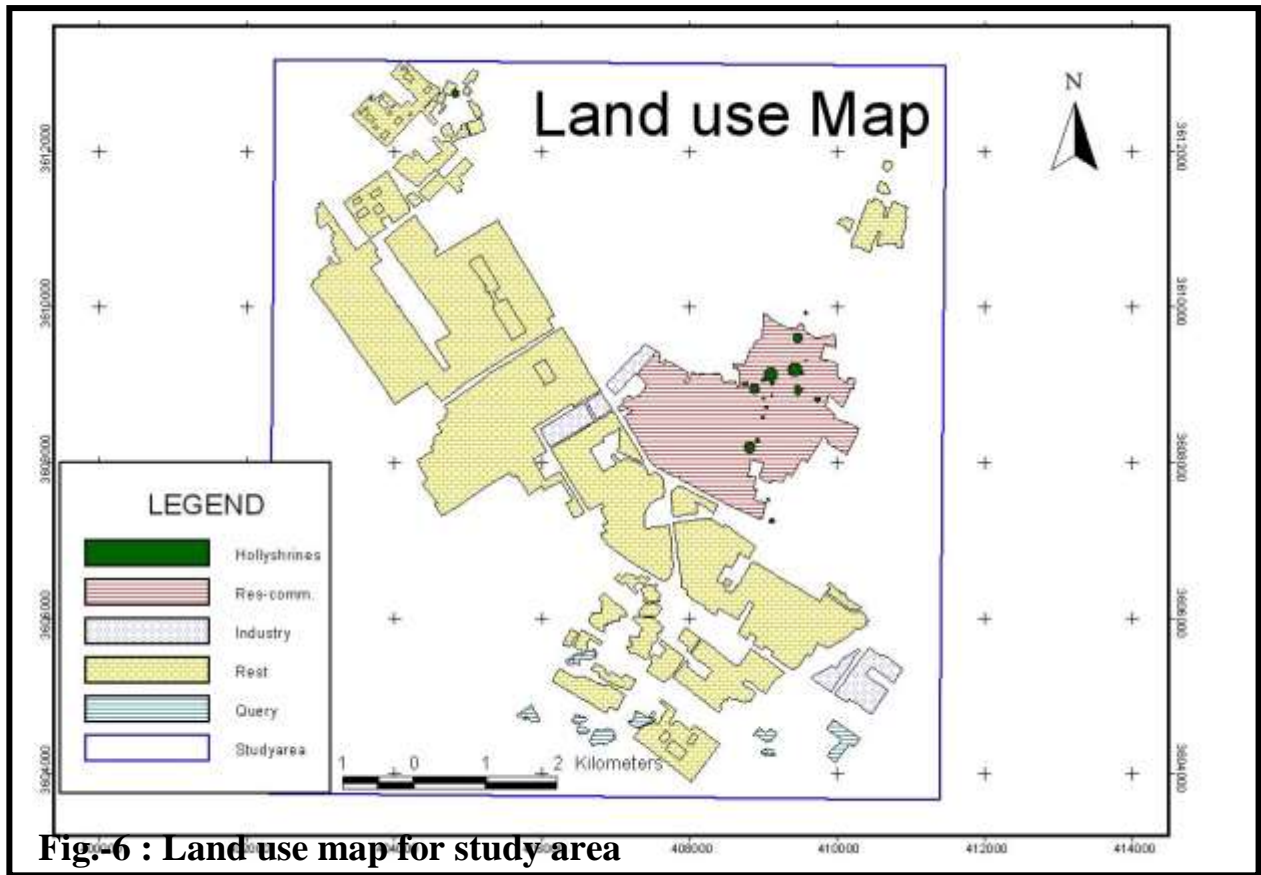
swamp
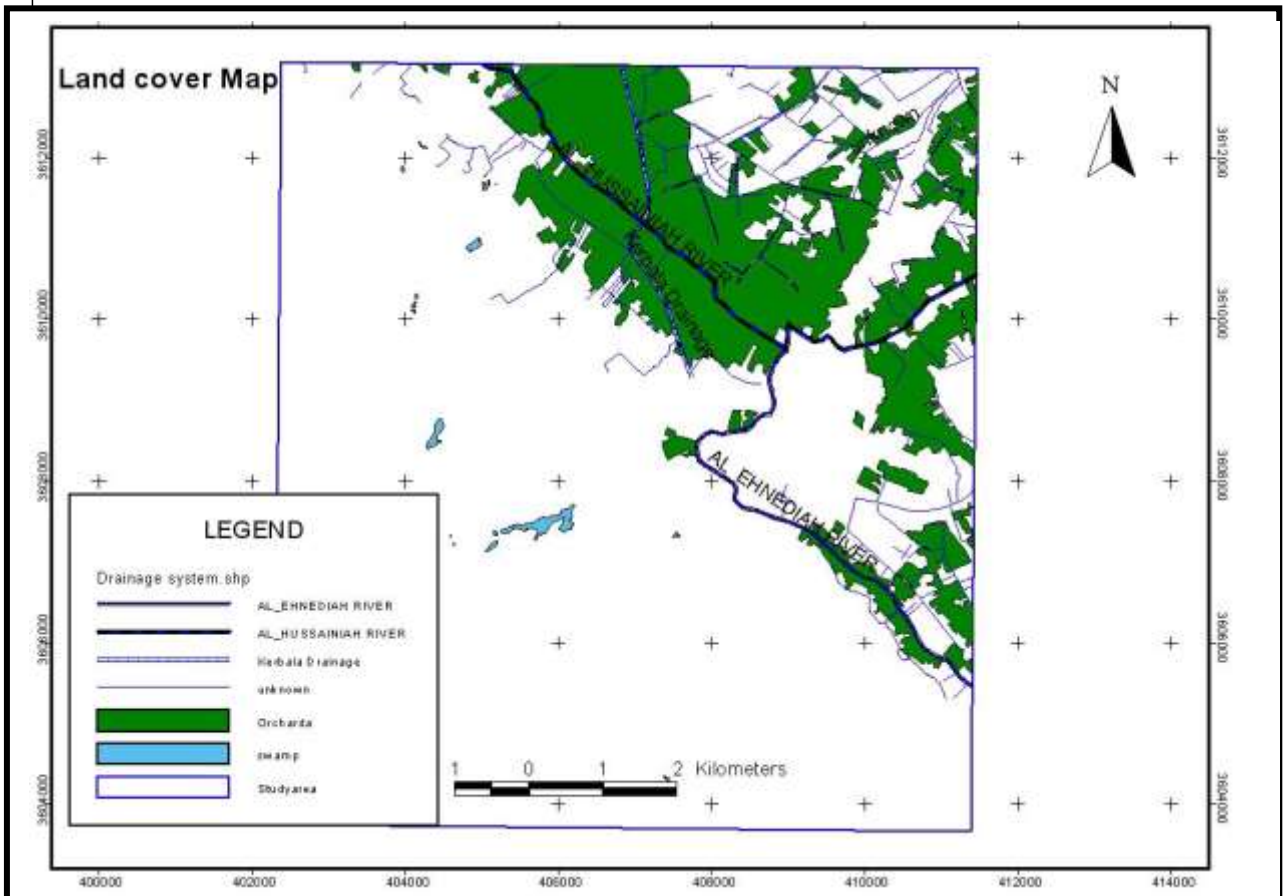
Studyarea

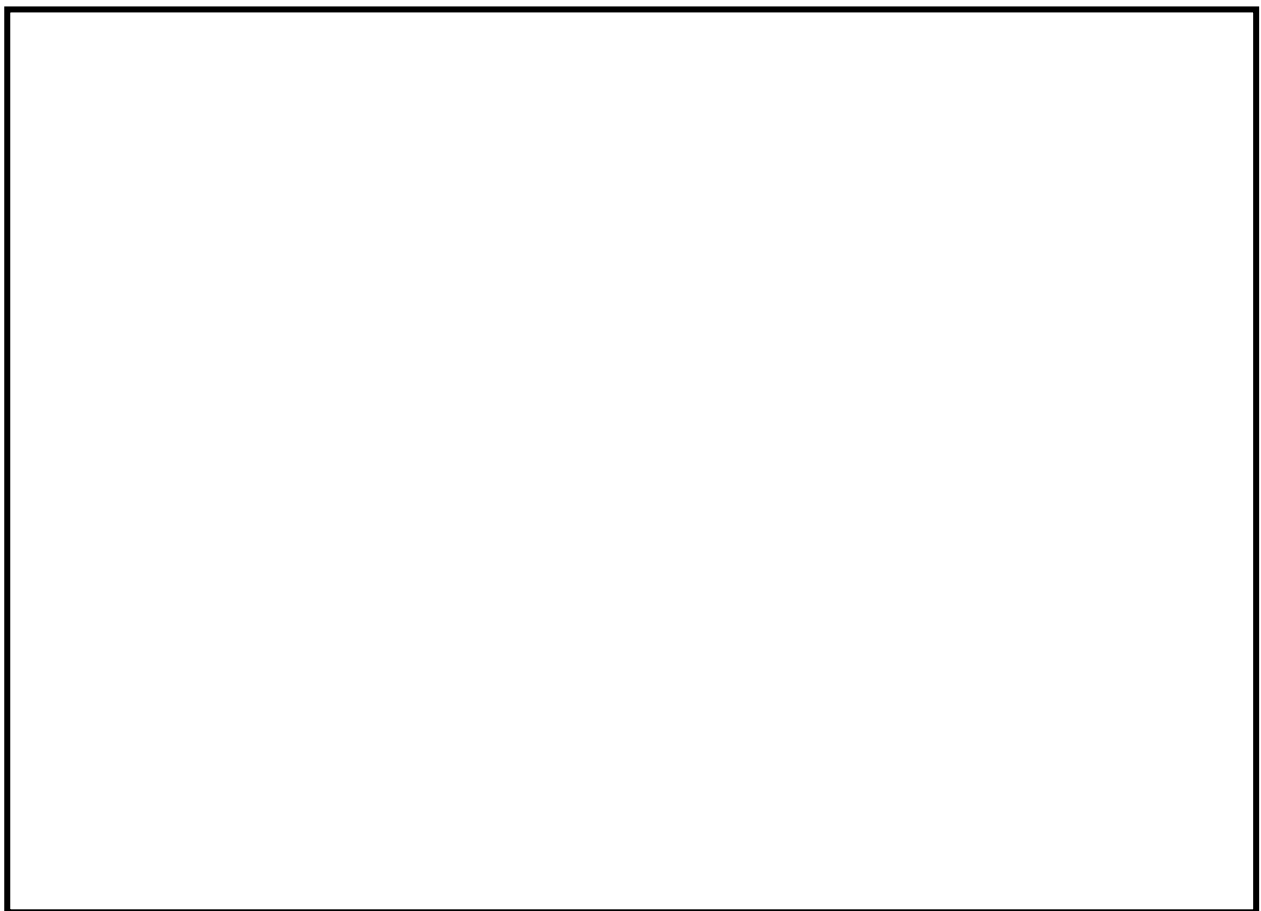**Fig.-6 : Land use map for study area**

Fig.-7 : Land use and Land cover for study area

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