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Settlements and Landscape (Siting And Evolution Of Cities In Relation To Regional Landscape Resources. The Role of Landform, Water Systems, Climate and Vegetation)

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Abstract

Settlements occupy an important position among all the visual imprints made by man upon the physical landscape through the process of cultural occupancy since the dawn of human civilization. The evolution and growth of a settlement in an area is the result of the interplay of the prevailing ecological conditions, cultural and social values of the residents, technology, management system and the settling process through time span. In the initial stage, settlement bear simple forms and have closed relationship with environment. However, increased of knowledge and growth of civilization increases variability in the forms and sizes of settlements. The interaction of human settlements on the environment is that they extract non-renewable natural resources on the one hand and, on the other, produce waste products and pollution that has to be absorbed by the natural environment. As the population grows, urbanizes and consumes more, the impact of human settlements on the natural environment increases. In South Africa, as in the rest of the world, these processes present a considerable challenge to governments and much effort is placed on creating sustainable human settlements.
Regional landscapes reflect the cultural characteristics of their inhabitants. This can be seen in the architectural structures used in a region, and in the statues and monuments of local, national, or global significance. The special qualities of regional landscapes of many favoured destinations are increasingly at risk as these regions experience significant in-migration leading to rapid and unplanned population growth.

Keywords: *Settlement, Landscape, regional landscape, landforms, climate, water, vegetation*

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Aim
- To study the importance of landscape rescources in settlement
- To understand settlement pattern and the impacts on natural landscape resources
- To comprehend the interrelationship between environmental factors and early human settlement

Objectives
- Expand the general knowledge known about Settlements and Landscape
- To analyze the impact of landscape resources on settlements and vice versa
- To spread awareness about the importance of existing natural resources like water, topography and vegetation and to make the best use of it

Limitations
- The research has limited access o data and sources
- Secondary data like existing research papers, blogs, articles and journals serve the main information sources
- The research will rely onthe literature available.

Methodology

- The methodology for the study is descriptive and analytical.
- Online survey is applied due to covid 19 pandemic as live survey is restricted.
- Case studies to help explore and analyse the potentials and drawbacks.

II. Literature Study

2.1 Introduction

In geography, statistics and archaeology, a **settlement**, **locality** or **populated place** is a community in which people live. The complexity of a settlement can range from a small number of dwellings grouped together to the largest of cities with surrounding urbanized areas. Settlements may include hamlets, villages, towns and cities. A settlement may have known historical properties such as the date or era in which it was first settled, or first settled particular people.

In the field of geospatial predictive modeling, settlements are "a city, town, village or other agglomeration of buildings where people live and work".

A settlement conventionally includes its constructed facilities such as roads, enclosures, field systems, boundary banks and ditches, ponds, parks and woods, wind and water mills, manor houses, moats and churches.

The oldest remains that have been found of constructed dwellings are remains of huts that were made of mud and branches around 17,000 BC at the Ohalo site (now underwater) near the edge of the Sea of Galilee. The Natufians built houses, also in the Levant, around 10,000 BC. Remains of settlements such as villages become much more common after the invention of agriculture.

2.2 Settlement in landscape history

Landscape history studies the form (morphology) of settlements – for example whether they are dispersed or nucleated. Urban morphology can thus be considered a special type of cultural-historical landscape studies. Settlements can be ordered by size, centrality or other factors to define a settlement hierarchy. A **settlement hierarchy** can be used for classifying settlement all over the world, although a settlement called a 'town' in one country might be a 'village' in other countries; or a 'large town' in some countries might be a 'city' in others.

2.3 Historical basis of settlement and landscape studies: founding fathers

Settlements occupy an important position among all the visual imprints made by man upon the physical landscape through the process of cultural occupancy since the dawn of human civilization. The evolution and growth of a settlement in an area is the result of the interplay of the prevailing ecological conditions, cultural and social values of the residents, technology, management system and the settling process through time span.

In the initial stage, settlement bear simple forms and have closed relationship with environment. However, increased of knowledge and growth of civilization increases variability in the forms and sizes of settlements. The study area, Bharatpur District, is one of the most early settled region of the country involves interesting pattern of human congregation for which it has been purposively selected for making a humble contribution to growing field of settlement geography. The district has an agrarian base and present diverse physio-cultural and socio-economic condition at micro-level in its different parts. It is one of the most ancient settled region and has long history of peopling and occupancy. Several archaeological findings, historical records and local legends pertaining to the pre-historic time, show that the study area was initially occupied by Matsya tribe before the Aryans. Inspite of the intermixing of various ethnic groups and cultural traits from within and outside the area has preserved its own traditions, culture, myths, norms and values, which has resulted in shaping the uniqueness in its identity. The objective of the present study is:

1. To study the physical, cultural and demographic parameters that give rise to variation in the macro and meso region of the study area, as base for human settlements.
2. 2. To trace the evolution of rural settlements from pre-historic to modem period with the help of cultural ecology and place names analysis.

2.4 What do we mean by site and situation of a settlement?

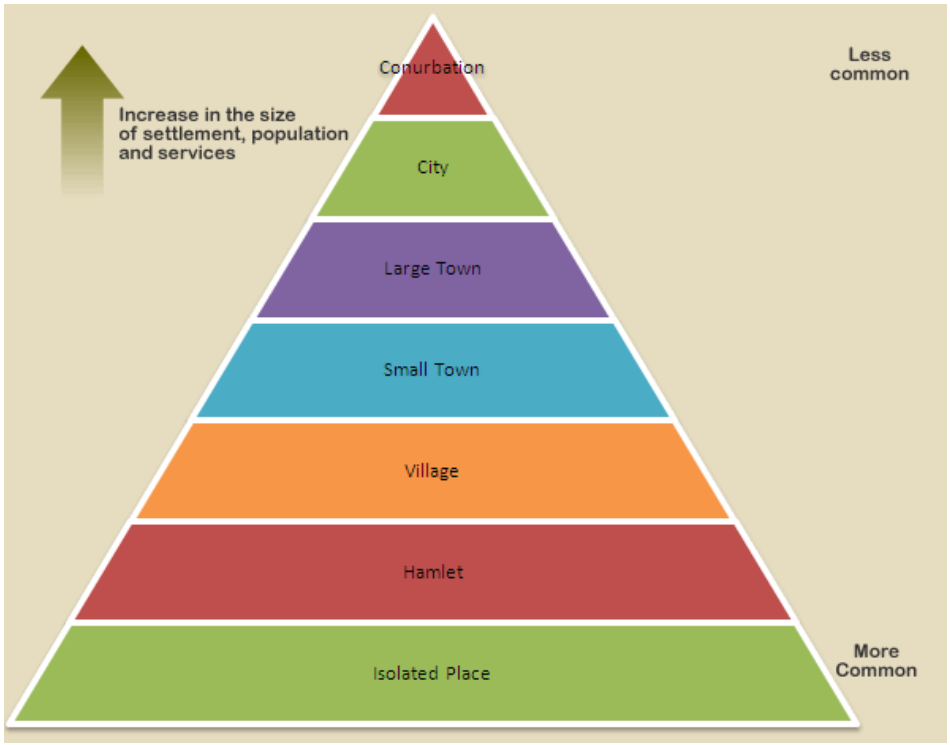
The site and situation of a settlement are very different things. The site of a settlement is the land

upon which it was built. There are a range of factors that can determine the site of a settlement. These are:
wet point site - these are sites close to a supply of water dry point site - these are sites that avoided the risk of flooding defensive site - these were sites that were on high ground and allowed the inhabitants to see enemies from a distance aspect - many settlements in the northern hemisphere are located on south facing sides of valleys where it is sunny shelter - away from rain and prevailing winds trading point - often settlements developed where natural training points meet such as along rivers or natural route ways resources - many settlements developed close to where natural resources could be found.

The situation of a settlement is its location in relation to surrounding human and physical features. We usually describe the situation when we are telling someone where a settlement is.
What are the functions of asettlement?
Most settlements in MEDCs have multi-functions. This includes education, retail and industry. However, when settlements first formed they often had one main function.
These functions included:

- port
- market town
- Resort

2.5 What is a settlement hierarchy?
We can catagorise settlements according to their size and shape. The result is a settlement hierarchy.



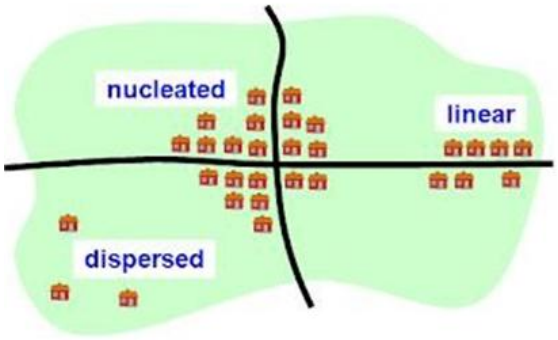
As you move up the settlement hierarchy the size of the settlement increases, as does the population and the range of services available. Smaller settlements tend to provide only low order services such as a post office and newsagents. Whereas, larger settlements have more high order services such as leisure centers and chain stores. As the result of this the larger the settlement, the greater the range of services and therefore the market area or sphere of influence. This is the market area that a settlement services (the distance people will travel to use services). High order services usually have a high threshold. This means they need a higher number of people to use the service in order to remain profitable. This means high order service such as department stores need a greater number of customers than a low order service such as a newsagent. This is why there are so few department stores in villages

2.6 What are the characteristics of settlements? Settlements come in all different shapes, sizes and locations. The function of a settlement can be identified by looking at its shape, size, site and situation.

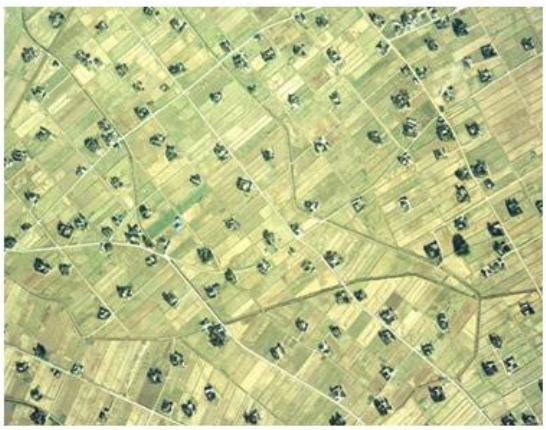
2.7 Settlement types

There are 3 different shapes of settlement according to the arrangement of buildings within them

- An **isolated settlement** consists of a single farm or house very remote from any other one, usually found in farming or hunting rural communities.
- Linear settlements grow in a line, often along roads, river valleys or the coast.
- Nucleated settlements have buildings grouped close together and are found at cross roads or are used for defence purposes.
- Dispersed settlements have individual buildings spread out, and are often found in rural areas.



Nucleated settlements



Dispersed settlements

Linear settlements

2.8 Classification according to size and housing density

Size and housing density are used together with settlement functions to classify settlements into major categories i.e.rural and urban.

Rural settlements are often small in size and have low housing and population densities.

Urban settlements are larger in size and have many houses built close together.

2.9 Rural settlements

Rural settlements can further be broken down into these four grades on the basis of size; homestead*, *farmstead, hamlet* and *village*.

A **single homestead** has just one compound, usually isolated and owned by a family, and one may be many kilometers from the next.

A **farmstead** consist of two or more homesteads, usually dispersed in a farmland and occupied by up to fifty individuals.

A **hamlet** is made up of several dispersed, nucleated or linear homesteads generally with shops, schools or other service centers and occupied by some hundreds of persons who are engaged in primary activities like farming, hunting and fishing.

A **village**, like a hamlet, may be dispersed, nucleated or both nucleated or linear, but the village has more homesteads and the population may be up to several thousands. The people engage in primary occupations, but there may also be craft and cottage industries, and service centers like schools, post offices, health centers and markets.

2.10 Urban settlements

Urban settlements can equally be graded into four, according to size. These are *towns, cities, conurbations* and *megapolis*.

Towns are urban settlements of up to several thousand persons. Houses are built together and the emphasis is more on secondary and tertiary rather than on primary occupation. Usually, a town has large chain stores, and many other social and commercial facilities.

Cities are the major towns of a country, like the major state capitals which have administrative functions. The old concept of a city being a walled town is no longer tenable as cities are no longer walled these days. They are generally larger than towns.

A **conurbation** grows when two or more towns or parts have grown and joined together to form a large urban area of 1 million persons or thereabouts. The boundary between original towns becomes blurred, just like we have in Lagos (Ikeja) and Accra (Tema).

Megapolis are several cities or conurbations which have grown over the years and have joined together to form a massive sprawling urban settlements. Such settlements stretch over several square kilometers and, as conurbations, it is difficult to known where one original city ends and the other begins. Megapolis is the highest in the hierarchy of urban settlements. Examples are New York-Boston-Philadelphia and Greater Los Angeles (USA), Tokyo (Japan), Greater London (Britain), Mexico City (Central America), and Dusseldolf-Duisburg-Essen-Dortmund, in the Rhur manufacturing region of Germany.

2.11 Factors influencing the location and growth of settlement

The factors that affect spatial aspects of set t 1 ement are as complex and varied as are the pat terns of distribution. Not only the physical environment is operative in determining cultural environment and location of settlement, but socio-economic and political factors also play a vital role in determining the establishment of settlement. Among the physical environment, topography, geology, terrain, climate, drainage, forest and soil are the significant factors.

Depending upon the location of settlements above mentioned factors, certain factors that influence are

i) Settlement on the hill top and hill slope

i) Settlement along the watershed

ii) Settlement along the main road iv) Settlement along the river.

2.12 Settlement on the Hill Top and Hill Slope wrt Mizoram

The location of settlement on flat hill top and gent 1 e hi 11 slope terra in was the marked characteristic feature of the hills as defence in the Pre-British period was the most decisive factor in

selection of sites for settlement. This choice is also favoured by congenial climatic condition. A numerous settlements, both large and small are situated on the hill tops and hill slopes of the State. The researcher who conducted an extensive field work had no doubt that about 50 per cent of the total settlements in Mizoram are situated on hill top and hill slopes. The remarkable mountain ranges which support . settlements of this type are Hachhek Range in the northwestern part, Chalf ilh-Ratu Range in the north central, Sialkal Range in the north-east, Zopui-Tan-Lurh Ranges in the east, etc. All these ranges are characterised by high degree of slopes and rugged topography that compels the inhabitants to occupy the hill top and hill slopes. The hill top and hill slope settlements are a common

2.13 Physical factors that influence the location of a settlement include;

1. Water supply – settlements need water, they often locate on wet point sites for this. Settlements built away from rivers and water supplies to avoid flooding are located at dry point sites.

2. Defence – building on high ground allowed people the chance to look out for enemies (e.g. Edinburgh castle) while surrounding a settlement with water also helped with deed defence e.g. Durham is built inside a meander.

3. Aspect and shelter – In the northern hemisphere south facing slopes receive more sunlight and are protected from cold Northerly winds. More settlements and agricultural land is therefore located on South facing slopes.

The economic factors include;

- Communications – settlements often located next to rivers that could be easily crossed. These are called bridging points. Other favourable places included where at the junctions of valleys or
- in gaps through hills. These locations allowed maximum communication between different settlements and increased
- trade. E.g. Newcastle is built on the Tyne at a bridging point and could benefit with trade from the North and the South.

Resources - Early settlers relied upon wood for fuel and building. A site close to woodland was there fore an advantage. Later, resources such as Iron ore, coal and bauxite encouraged the growth of settlements.

2.14 Background of Human settlement

Human settlement is a *place* where *people* live. It refers to the totality of human community with all the social, material, organizational, spiritual, and cultural elements that sustain it. Any form of human dwelling, from the smallest house to the largest city,
where group of people reside and pursue their life goals, can be understood as settlement. Human settlements come in many forms and can be permanent and temporary, rural and urban, mobile and sedentary, disseminated and agglomerated.
A great variety of settlements exists worldwide today reflecting human needs, abilities, and aspirations, as well as social, political, and economic relations. In this chapter, human settlements will be presented by reviewing their general characteristics, classifications, and hierarchies, as well as specificities of urban and rural settlements, their historical development, and the contemporary challenges they face.

2.15 Environmental change and its impacts on human settlement in the Changjiang River Delta in Neolithic age

Dating data, altitude of Neolithic sites, climatic changes from sedimentary records and previous research results were collected and analyzed to detect possible connections between climatic changes and human activities in the Changjiang River Delta in the Neolithic Age. The results indicated that hydrological changes greatly impacted the human activities in the study region. Low-lying geomorphology made the floods and sea level changes become the important factors affecting human activities, especially the altitude change of human settlements. People usually moved to higher places during the periods characterized by high sea level and frequent floods to escape the negative

influences from water body expansion, which resulted in cultural hiatus in certain profiles.

2.16 Factors affecting the location of human settlements.

There are many factors that can influence where settlements locate within a region.Physical factors that influence the location of a settlement include ; Water suppy - settlements need water, Defence - building on high ground allowed people the chance to look out for enemies and Aspect & shelter and The economic factors include; Communications - settlements often located next to rivers that allowed bridging points. These locations allowed maximum communication between different settlements and increased trade and Resources - early settlers relied upon wood for fuel and building.

2.17 Natural factors affecting the location of human settlement:

One of the most important factors for human settlement was rivers. Rivers are a source of natural fresh water and have **fertile land** near them, which are one of the **basic needs of civilisations**.
Humans started having settlements and civilisations around **300,000 years back**, the main factors for choosing an area for settlements were the presence of fertile lands, **natural sources of water** and **flat lands for home construction.**
Banks of rivers have provided all of the above factors, hence even now most of the world's biggest cities are found around rivers. However, nowadays there are also factors such as **livability standards, human employment standards, and crime rates.**
There are many factors that can influence where settlements locate within a region. The site of a settlement is the actual land that the settlements is built upon. The situation is the location of a settlement in relation to the things that are around it.

2.18 Relationship between human settlements and the natural environment with respect to South Africa

It deals with the state of South African human settlements and their impact on the natural environment. It focuses on the material conditions of the entire spectrum of human settlements from large metropoles or city regions to villages, and addresses a range of settlement elements.
On the most basic level, the interaction of human settlements on the environment is that they extract non-renewable natural resources on the one hand and, on the other, produce waste products and pollution that has to be absorbed by the natural environment.

However, some higher-altitude settlements were not the results of climatic changes but the results of social factors, such as religious ceremony and social status. Therefore, further research will be necessary for the degree and types of impacts of climatic changes on human activities in the study area at that time.
As the population grows, urbanizes and consumes more, the impact of human settlements on the natural environment increases. In South Africa, as in the rest of the world, these processes present a considerable challenge to governments and much effort is placed on creating sustainable human settlements.
Urban and rural sprawl, housing demand, modes and character of transportation and basic service infrastructure, are the physical elements of human settlements that have the most noticeable impact on the natural environment and are the focus for the creation of more sustainable human settlements with a reduced ecological footprint.
Human settlements are of extreme social and economic importance. In South Africa, they generate more than 90 per cent of all economic activity and house over 70 per cent of the total population (CSIR 2011). Although they cover only seven per cent of the total area of the country, their environmental impact is huge.The relationship between human settlements and the natural environment or ecological systems is complex, iterative and continually changing. The natural environment provides the basic elements that human beings need to survive such as food, water and shelter (Box 5.1). In the process of harvesting the natural resources, human beings impact on the environment by overuse or exploitation of non-renewable resources and through the production of waste materials and pollution e.g. greenhouse gasses, ozone-depleting substances and hazardous materials. This leads to a degradation of the very environment that human beings depend on.
The impact of human settlements on the environment increases with population growth, settlement expansion, economic growth and increased consumption. All indications are that the impact of human settlements on environmental resources is increasing. The ecological footprint1 of South Africa for

instance, has increased from 2.32 ha worth of natural resources per person in 2010 to 2.59 ha in 2012(WWF 2012). This is however still lower than the world average of 2.70 ha (Chapter 2: Sustainability in South Africa).

2.19 Environmental Factors and Early Human Settlement

In ancient times, environmental factors influenced people's choices of where to settle. Three important environmental factors were water, **topography**, and **vegetation**.

2.20 Role of Water

The most important environmental factor in early human settlement was water. Physical features like rivers, lakes, and inland seas were good sources of fresh water.

Water was important for many reasons. People needed fresh drinking water to live. They also bathed and washed things in fresh water. Bathing and washing helped prevent disease.

Water was a source of food. People caught fish from rivers, lakes, and seas. They hunted water birds and other animals that gathered near water.

In addition, farmers needed water to grow their crops. For this reason, farmers often settled near rivers. A river's natural flooding could help irrigate their farms. Farmers could also dig canals or trenches to direct river water to their crops. For example, farmers in Mesopotamia dug canals for this purpose.

Water was also used for transportation. Cities and towns often used rivers as ―highways.‖ People traveled in boats to visit relatives and trade goods. Towns near the sea could trade goods with countries far away.

Box 5. 1: Settlements and the water cycle

An example of the impact of human settlements on the environment can be found in the water cycle. Human settlements reduce evaporation from 40% to 30%, reduce infiltration of water to underground aquifers from 50% to 15%, and increase run-off from 10% to 55%. The implications of these figures for replenishment of underground water (an important source of drinking water for humans) and for increased flooding is evident.

2.21 Role of Topography

A second environmental factor was topography. Topography refers to the shape and elevation of the land. It includes features like mountains, hills, plains, valleys, and deserts.

The topography of an area was important for early human settlement. Farmers preferred to settle in flat, open areas such as plains and valleys. Large, flat spaces gave farmers room to plant crops. Also, the rich soil in coastal plains and river valleys was excellent for growing these crops.

Mountains were less friendly to human settlement. Steep mountains were hard to cross. Their jagged peaks, cold temperatures, and rocky land made farming difficult.

Deserts also discouraged settlement. They were hot and dry. They contained very little water for farming. Sandstorms occurred when strong winds carried dense clouds of sand that could block out the sun. The intense heat, lack of water, and sandstorms made travel and living in the desert difficult.

2.22 Role of Landform

Role of Landform in Differentiation of Ecosystems at the Mesoscale (Landscape Mosaics)

Macroclimate accounts for the largest share of systematic environmental variation at the macroscale or ecoregional level. At the mesoscale, landform (geology and topography) breaks up the broad patterns. For example, solar energy will be received and processed differently by a field of sand dunes, a lacrustrine plain, or an upland hummocky moraine. Within the same macroclimate, broad-scale landforms break up the east-west climatic pattern that would occur otherwise and provide a basis for further differentiation of mesoscale ecosystems, known as landscape mosaics. The character of a landscape mosaic with identical geology will vary by the climate zone. For example, vertical limestone would form quite different landscapes in a subarctic climate than in hot and arid climates. Limestone in a subarctic climate occurs in depressions and shows intense karstification, whereas in hot and arid climates, it occurs in marked relief with a few cave tunnels and canyons inherited from colder Pleistocene time. Landforms (with their geologic substrate, surface shape, and relief) influence place-to-place variations in ecological factors, such as water availability and exposure to radiant solar energy. Through varying height and degree of ground-surface inclination, landforms interact with climate and directly influence hydrologic and soil-forming processes. Landform is the best correlation of vegetation and soil patterns at meso- and microscales. This is because landform controls the intensity of key factors important to plants and to the soils that develop with them (Hack and Goodlet 1960; Swanson and others 1988). The importance of landform is apparent in a number of approaches to classification of forestland (for example, Barnes and others 1982). Even in areas of 4 relatively little topographic relief, such as the glacial landforms of the upper Midwest of the United States, landform explains a great deal of the variability of ecosystems across the landscape (Host et al. 1987)

Principal landform classes Landforms come in all shapes and scales. On a continental scale within the same macroclimate, we commonly find several broad-scale landform patterns that break up the zonal patterns.

The landform classification of Edwin H. Hammond (1954, 1964), who classified land-surface forms in terms of existing surface geometry, is useful in determining the limits of various mesoecosystems or landscape mosaics.

2.23 The effect of landform on site patterns

According to its physiographic nature, a landform unit consists of a certain set of sites. A delta has differing types of ecosystems from those of a moraine landscape next to it.

The sites are arranged in specific patterns, according to the way they break up the zonal climate. The mountains and tablelands of the west-central part of North American illustrate this. For example, the high Idaho Mountains and the high-relief tablelands of 5 the Yellowstone Plateau are both located in the Rocky Mountains, a temperate-steppe regime highland.

2.24 Role of vegetation in human settlement

Demography and ecology have long been intertwined in terms of understanding the relationships between population and the environment. Recent advances in data and technology, coupled with our increased understanding of social and ecological process, have greatly expanded the ability to link populations and ecosystems in order to understand their interrelationships. However, there remains a paucity of understanding of how climatic variability relates to the spatial patterning of people and how they may influence one another. Here we couple MODIS satellite estimates of inter annual

photosynthetic variability from 2000–2011 with housing density for the year 2000 to provide an estimate of the interaction between productivity dynamics and exurban influence at a 2 km resolution for the conterminous United States. The resultant map shows the convergence of population and climate influences on vegetation responses with broad patterns of interaction across the United States and notable extremes found throughout the Central Plains and localized regions of the Southwest US. These intersections of land use and vegetation dynamics have significant implications for ecological systems and ecosystem responses to climate dynamics

2.25 Regional landscapes

Regional landscapes reflect the cultural characteristics of their inhabitants. This can be seen in the architectural structures used in a region, and in the statues and monuments of local, national, or global significance.The special qualities of regional landscapes of many favoured destinations are increasingly at risk as these regions experience significant in-migration leading to rapid and unplanned population growth. These challenges are particularly acute for metropolitan regions experiencing rapid peri-urban and urban growth. It has been the nature and the rapidity of this population growth that has seriously challenged planners and policy makers responsible for the proper management of these metropolitan region. At stake are a number of important landscape attributes that define a region and provide its special locational and environmental qualities that are a major contributing factor to its high degree of liveability and quality of life. It is these special qualities that act as magnetic ‗pull factors' that contribute to the attraction for the migrating population and establish the region as a popular tourist destination.
This paper considers the case of the rapidly growing metropolitan region and asks the question: Do we have adequate planning paradigms and conceptual frameworks to safeguard regional landscape values at risk from unchecked peri-urban expansion in rapidly growing metropolitan regions?

III. Case study 1

3.1 Landscape and Settlement with respect to ireland

Ireland's landscape diversity is a product of glacial processes operating on the geological base of carboniferous limestone in the central lowlands and on ancient folded mountain ridges to the north and south. Glaciations more than 12,000 years ago eroded material from the uplands and deposited it as gravels and clays (in eskers, drumlins and moraines) on the midlands. These thin out in the western counties, where the underlying rock appears on the surface, most notably in the karst landscapes of Clare and Galway and the granites of Connemara. Eskers are ridges of gravel that were formed by streams and rivers underneath the ice sheets, and were important routeways historically through the midland bogs of the island.

3.2 Boglands

Seventeen percent of the surface of Ireland is composed of peat bogs. Raised bogs are found in the lowlands, while blanket bogs are more characteristic of the uplands and western regions. The lowland bogs comprise great domes of undecayed matter, mostly sphagnum mosses, which accumulated in hollows and water-logged basins in postglacial times up to 8,000 years ago. Esker and morainic deposits of gravel obstructed the natural drainage, accelerating the growth of peat up to seven or eight meters in depth. Blanket bogs developed in the much wetter conditions of the western parts of the country, where the peat lands have spread over the hills and with their distinctive moor grasses and sedges add color and texture to the mountain landscapes. Deteriorating climatic conditions about 6,000 years ago and localized forest removal encouraged the spread of blanket peat over many prehistoric settled landscapes. The most dramatic recent discovery (in the 1970s) has been the uncovering of Céide Fields underneath the blanket peat in north Mayo, where an extensive field system with accompanying house and tomb sites dates from 3,700 to 3,200 b.c.e. Further ancient landscapes may still await discovery underneath the peatlands of Ireland.
Much of the midlands is honeycombed with fertile land as islands in the extensive wet boglands. During the early Middle Ages, this labyrinthine pattern of eskers and boglands sheltered a largely tribal localized culture familiar with the intricacies of passes through the bogs. Tyrellspass in County Westmeath commemorates one such pass through the bogs.

One of the largest of these eskers was called the *Eiscir Riata,* which was an important pass in prehistory between the northern and southern parts of Ireland. The significance of these medieval routeways is today marked by the remains of monastic sites like Clonmacnoise, Clonfert, Terryglass, Durrow, Tihilly, Seirkieran, Kinitty, Rahugh, and Clonard.
The significance of these medieval routeways is today marked by the remains of monastic sites like Clonmacnoise, Clonfert, Terryglass, Durrow, Tihilly, Seirkieran, Kinitty, Rahugh, and Clonard.
In modern Ireland, as elsewhere in Europe, the great bogs were seen negatively as obstacles to development and refuges for rebels and other persons evading the laws of the Anglo- Norman and Tudor state. Canal construction in the late eighteenth and early nineteenth centuries had the double advantage of providing an opportunity to drain these wetlands at the same time as bringing trade and commerce to the midland regions. Historically peat harvesting was a traditional local activity—"cutting turf" with spades in local communities was a centuries-long tradition throughout Ireland. Turbary rights, which went with farm leases from the seventeenth century, were important local assets and landlord interference with these rights often led to local disturbances. Many small bogs were extinct by the twentieth century, with cutover and cutaway bog forming important landscapes in parts of south Ulster and on the margins of the midland bogs. By the twentieth century the more extensive bogs were seen as opportunities for industrial harvesting and local economic development. A state peat
authority (*Bord na Móna*) was established in 1946 to excavate the peat mechanically for electricity generation, for domestic fuel as peat briquettes, and as a horticultural product in form of peat moss. In the last quarter of the twentieth century popular interest in
the conservation of these bog landscapes increased, and tourism and local interests have realized the botanical and environmental value of these extensive landscapes.

3.3 The Peopling of Ireland

The Irish environment has formed a stage for human settlement for thousands of years. The interaction between the environmental endowment and humanity on this small island has resulted in a tremendous topographical variety at the regional and local level, and this in turn has been one of the main driving forces forculturaltourism.SituatedontheAtlanticfringesofEurope,much of Ireland's landscape and cultural experience is a product of peoples and processes diffusing out of the European mainland.
The earliest Mesolithic hunter and gatherer communities arrived in Ireland about 9,000 years ago after the end of the Ice Age. These small groups lived along riverbanks and estuaries, lake shores, and coastal districts, exploiting fish, plant, and animal resources. Neolithic settlement (from 5,000 years ago) using Stone Age technology, constituted the first farming communities—a civilization marked by the appearance of important megalithic tombs. Court, portal, passage, and wedge tombs (referring to the arrangements of spaces, particularly of the entrance to the tomb, within them) have been located in different regions, suggesting a variety of population groups settling in the landscape.

The enormous passage tombs at Newgrange in County Meath and at Carrowmore in County Sligo were built about 3,500 to 3,000 b.c.e. and are part of an array of similar tombs in Brittany and western Iberia, a phenomenon that emphasizes the importance of the seaways along the Atlantic fringes in early migrationflows.
The Bronze Age (c. 2,500–600 B.C.E.) was marked by copper-mining people who produced personal ornaments and jewellery of great beauty, as well as constructing large hilltop enclosures like Navan Fort near Armagh and great ceremonial circles and henges, such as those in the Boyne valley. From about 600 b.c.e. an ironworking culture spread to Ireland from continental Europe and made a significant contribution to the island's landscape and culture. Much of the linguistic and genetic heritage of the Irish people can be traced to this Iron Age Celtic culture. Most of the great fables and mythic figures, such as
the *Táin Bó Cuailnge, Cuchulainn,* and *Fionn Mac Cumhal,* originated with these peoples.
The Celts made a lasting cultural impact on the Irish landscape in terms of its territorial and political order and its place- names. The historic provinces of Connacht, Leinster, Munster, and Ulster are simplified legacies of more complex divisions of the island among early Celtic population septs (lineage or kin groups). In broad terms they coincide with major environmental regions. The
names of Ulster, Leinster, and Munster are ninth-century Norse constructions of earlier Irish names: Ulaidh or *Cúige Ulaidh* (literally the "fifth of the men of Ulaidh"), Laighin or *Cúige Laighin,* and Mumhan or *Cúige Mumhan*; the "fifth" is evidence of the probable existence of *Mide* as another provincial territory.

Tír, the Irish word for territory, was added by the Norse to make *Laighins-tír* and so on. A more detailed lattice of territorial divisions emerged within the provinces, as population groups expanded and formed tribal entities. Approximately 150 tribal units known as *Tuatha* emerged, many of which formed a template for the medieval territorial lordships and baronies of the Gaelic and Anglo-Norman settlements. Tuatha were grouped into kingdoms, whose geographies have survived in dioceses established by the church in the twelfth century.

By the Middle Ages, many of the tiny local territorial units known as townlands (of which there are more than 60,000 today) had taken shape as Gaelic landholding units, and many of their names continue in use.

Large fortified stone forts like Grianán Aileach in Donegal or Staigue in Kerry and other earthworks like Tara and Knockaulin (DÚN Ailinne) were constructed during the Iron Age. Linear earthworks such as the Black Pig's Dyke (500–100 B.C.E.), which runs across the south Ulster landscape, and upwards of two hundred promontory forts in coastal locations represent attempts in this period to provide a form of regional security.

The early Christian period contributed some of the more familiar components of the Irish landscape. The ubiquitous ringforts (more properly called *rath* and *dún*) represented a pattern of dispersed farmsteads throughout the island, which are assigned to the second half of the first millennium. Raths refer mainly to sites built of earth; dÚN refer to larger, more prestigious examples.

Ringforts in more rocky terrain were built of stone (called *caiseal* or *caher*), some of which contain the remains of houses within the enclosure. More than 50,000 of these circular enclosures (with single or multiple banks and ditches) were built in this period. They have been preserved down through the centuries as a result of superstitious associations with "fairy forts." Modern agricultural development, however, has destroyed great numbers of them. Crannogs or lake dwellings were settlements built for security in the period from 500 to 1000 c.e. on artificially constructed islands in lakeland regions especially in the northern half of the island.

The early Christian monastic church in Ireland established sites that came closest, in function if not in form, to urban centers in early Ireland. A large number of significant centers developed, such as Clonard, Clonfert, Clonmacnoise, Durrow, Devenish, Derry, and Armagh. They became the centers of federations of settlements, often located on sites with pre-Christian significance, populated not only by monks but by secular communities working at a variety of crafts. Located along important routeways through the midlands and associated with the settlement pattern of ringforts, it is likely that these monastic centers probably played a key role in contemporary rural economies. Becoming extensive owners of land, they were at the forefront in clearing woodlands, cultivating cereals, and managing livestock. As points of early wealth accumulation, they were repeatedly plundered by Viking raiders in the ninth century. Monastic sites mirrored ringfort morphology, though their circular enclosures were more extensive. The street morphologies of many small towns that originated on these sites still show the curve of ancient monastic boundaries. Throughout the Irish countryside today there are also the remains of small early medieval church sites, usually located at walking distances in the landscape and frequently marked by circular-shaped cemeteries. These small rural parishes from the early medieval period sometimes have holy wells associated with their founder, at which pattern (patron)-day pilgrimages still occur.

Later, more lavish ecclesiastical buildings followed attempts to reform the old church in Ireland, with impressive new structures like those at the Rock of Cashel being built in the twelfth century. Abbeys such as Boyle in County Roscommon, Mellifont in County Louth, and Holy Cross in Tipperary are the work of continental orders (Cistercians and Benedictines) who came to Ireland in the early twelfth century and who pioneered a new phase in agricultural activity. Most of the medieval ecclesiastical structures in Ireland are in ruins today following the dissolution of the monasteries in 1536 at the time of the Protestant Reformation. The Established Church of Ireland inherited the ecclesiastical buildings, but never obtained the allegiance of the majority population in Ireland, so that maintenance of the structures was difficult.

A number of significant immigrations from the ninth century contributed to the modern Irish landscape. The Vikings (or Norsemen) first arrived on raiding missions from Scandinavia in the late eighth century, and although there is evidence of their having settled in parts of the countryside as farmers, they have been credited mainly with introducing the first urban overseas trading settlements around the coast in the ninth and tenth centuries, and these have endured to the present. Dublin grew into a major Norse settlement presiding over a kingdom that embraced the lower Liffey valley. Port towns were also established at Waterford,

Wexford, Cork, Youghal, and Limerick, all place-names incorporating linguistic elements of Norse.
The Anglo-Norman colonization that occurred in the eighty years after 1169 represents the beginnings of Ireland's centuries-long political and cultural engagement with the neighboring island kingdom of England. The invaders who came from the western regions of England and Wales were part of the expanding Angevin empire that had engulfed Anglo-Saxon England a century earlier. The Anglo-Normans were responsible for the introduction of a fully fledged feudalism into Ireland, expressed on the ground in a manorial system of land organization, an open- field tillage economy, incastellation of the countryside, and establishment of an embryonic market system. However, it was an incomplete colonization, with large parts of the island remaining under Gaelic control. The English Pale emerged through the Middle Ages as the principal region of English control in Ireland, containing a king's representative in Dublin and a parliament that was subservient to England. Outlying feudal lordships and liberties in Munster and Connacht had a weakened connection with the English crown, and pressure from Gaelic lordships on the borders of the colony from the fourteenth century resulted in contraction and gaelicization of the colony. Most of the counties of Leinster and Munster were created by the Anglo-Normans by the thirteenth century as part of the administration of the colony.
By the mid-sixteenth century the expanding English state began a process of subjugation of Ireland that involved the elimination of regional lordships and the incorporation of the island as a unitary economic and political entity. This policy was carried out through a sometimes brutal series of land confiscations and plantation schemes that encouraged planters and settlers to come from Britain. This process of settlement continued into the middle of the seventeenth century, leading to an effective modernization of the Irish landscape with the introduction of a commercial landed-estates system and the consolidation of a market economy over the entire island. Where possible, British (Protestant and Presbyterian) settler tenants were brought in to introduce new farming methods, especially in Ulster. The native (mainly Catholic) population was largely dispossessed of landownership and relegated to tenant status. New plantation towns were added to the medieval urban network and were important agents of economic development in Ulster especially. The remaining counties of Ireland were created during these sixteenth- and seventeenth- century plantations as jurisdictions of local administration.

3.4 The Woodlands

Although there was continuous forest clearance in Ireland from ancient times, most of the native forests were destroyed during the seventeenth century in response to the demands of an expanding mercantile economy and a rush to exploit the country's natural
resources by new British settler communities. By the middle of the eighteenth century the Dublin parliament and the owners of Irish landed estates were concerned at the denuded state of the Irish woodland resources. Reflecting a Europeanwide age of improvement, the Royal Dublin Society, for instance, offered incentives to landowners and tenants to plant estates with hardwoods. Much of the legacy of beech, oak, and lime trees today can be traced to this period of planting and continues to be an important feature in Ireland east of the Shannon, especially in the demesne lands of former estates. In the more windswept west of the country the landscape is largely treeless.

3.5 Fields

The most common features in the landscape today are the hundreds of thousands of individually enclosed fields, separated by hedges, banks, and ditches. In the rockier western regions fields are enclosed by an intricate mesh of stone walls. Most of this enclosure occurred in the largely open-field landscapes that prevailed before the eighteenth century and is part of a revolution in agriculture that diffused throughout the British Isles, reaching the west of Ireland latest after the famine in the 1840s. Unlike England, where parliamentary enclosure reorganized most of the older medieval open fields, in Ireland the land was enclosed mainly by landlord and tenant initiative. The more commercially minded landowners in Leinster and Munster were at the forefront in having their lands enclosed in the eighteenth century as part of a drive for more efficient agriculture. Usually, the outbounds of the tenant farms were enclosed initially, with the tenants being left to hedge and ditch their own fields. In the 1820s and 1830s landlords in south Ulster were giving their tenants thousands of quick setts (whitethorn hedge plants) on the November "gale days" (rent days) to plant on their farms. As population soared in the decades before the Great Famine, farms and fields were subdivided and new boundaries installed. The story of the hedging of the countryside in its characteristic patchwork-quilt

pattern represents a critical formative phase in the making of the landscape and the sense of place today. Because of the intimate connection between farmer and field over generations of manual labor, field-naming was a common practice in many regions, adding another layer to place- names in the landscapes.

3.6 Estates

Most of the material features in the modern settlement landscape developed within the parameters of the landed estate. In common with much of Europe from feudal times, the land of the island was owned by a privileged minority.

This estate system was firmly established in Ireland following its final incorporation in the expanding modern British state. Some estates traced their origins to powerful Anglo-Norman families, but most emerged from plantation schemes or purchase in the sixteenth and seventeenth centuries. Landowners, who might generally be characterized as ascendancy and gentry, leased their land to tenant farmers for rent. Tenants were expected to make the land productive, through drainage and good husbandry. It was the large and small tenant, under the managing eye of the owner or his agent, who made the landscape, and who molded and imprinted on it the marks of his community and culture. Landless laborers were employed either by the landlord or the tenant, their numbers reflecting the nature of the local agricultural economy. The busy tillage lands of Louth and Wexford had large settlements of laborer cottages near the farms.

In the cattle-grazing midlands these were fewer. As population grew and employment shrunk in prefamine decades, it was the poorly managed estates that experienced the brunt of subdivision of the landscape. Landless populations squatted on marginal lands on the edges of the bogs, high up on mountainsides, or along new roads built to open up remote areas in Munster or Connacht. Landless sons added cabins to swelling house clusters in coastal regions and mountain valleys in the west, from which bands migrated seasonally to work in eastern counties, Scotland, or England. More carefully managed properties controlled their tenant populations, or encouraged some to leave under assistedemigration schemes in mid-nineteenth century. On these properties, mostly located in the east and south, landlords invested in large mansions and lavish walled demesnes with ornamental gardens and model farms. Many landlords were also involved in attempts to induce economic development in planned estate villages, with markets to encourage trade and frequently with colonies of textile workers. However, following the ravages of the Great Famine, the landlord system was largely discredited, and commencing with the disestablishment of the Anglican Church in 1869 and land legislation transferring ownership from landlord to tenant at the turn of the nineteenth century, the estates and the social system that they represented were dismantled. The truncated demesnes and big houses, intact or derelict, are all that remain as landscape markers of the estate system.

3.7 Buildings

The Irish heritage in buildings is modest by European standards. Before the seventeenth century, Ireland was a comparatively underdeveloped and politically fragmented entity, thus preventing the articulation of a significant island-wide economy. Unlike the rest of Europe, where significant remnants of the medieval-built environment survive, military and economic instability meant that most Irish medieval structures have been in ruins for more than three hundred years. The majority of inherited structures still in use today originated largely in the eighteenth and nineteenth centuries. The more significant buildings are the mansion houses of the wealthy landed elite—referred to as the "Big Houses" of the gentry, or as "stately homes" by heritage tourism— which accompany estates. Great houses like Carton, Castletown, Powerscourt, or Florencecourt, with their demesne landscapes largely intact, are important components in the modern landscape.

The houses of bigger tenant farmers aped the pretensions of their masters by embellishing their houses with a second story or a porch. Smaller tenant-farmer houses were more traditional in form, consisting of two or more connected rooms. Originally thatched, some survive, though most have been slated. The poorest category of house belonging to the landless laborer was replaced in the late nineteenth and early twentiethcenturies by local authority or state-sponsored cottages. Today, however, most of the traditional buildings in the countryside have been superseded by modern bungalow type dwellings, which are universal throughout the Irishlandscape.

The most important distinction in buildings is between the houses of the wealthy from the seventeenth to the nineteenth centuries, which engaged with a wider world of architecture, taste, and building materials, and those of the local tenantry.

Many of the eighteenth-century mansions reflect the impact of palladianism (derived from the ideas of the sixteenth-century Italian,Andrea Palladio), ornamented by fashionably popular Irish architects such as Richard Castle and craftsmen from Dublin or England. Frequently, building materials were imported, like the exotic plants for landlord demesnes. In contrast, the houses of the majority of the population were embedded in the local landscapes literally and metaphorically. Built by local craftsmen, they reflected the constraints of traditional practice and local materials in plan and construction. Consequently, as in the rest of Europe, the domestic buildings of local communities blended into the countryside, snuggling into landscapes from which stone, straw, or reeds were obtained.

3.8 Churches

Church buildings in Ireland reflect diverging allegiances in the population: the majority native population which adhered to Rome after the Reformation and whose churches were impoverished and often illegal through most of the eighteenth century, and the Protestant minorities whose smaller but better-built churches reflected their social and political privilege. The Established Church of Ireland, which was state endowed up until disestablishment in 1869, inherited many of the old medieval cathedrals and built many small, attractive country churches, which, because of dwindling congregations, have been abandoned throughout the south of Ireland in the twentieth century. Northern Ireland with its much bigger Anglican and Presbyterian congregations has a more extensive heritage of churches. The Catholic Church embarked on a building program from the early nineteenth century following Catholic Emancipation in 1829, though in places some older vernacular barn chapels have survived from the eighteenth century. Its churches are larger and reflect elements of a neo-gothic triumphalism in the nineteenth century.

3.9 Urbanization

Ireland's regional pattern of urbanization is a combination of a legacy of colonial settlement superimposed on a more ambiguous Gaelic pattern. South of a line from Dundalk to Galway lay a region of comparatively intensive urban settlements from the Anglo-Norman feudal economy. To the north the Gaelic landscape was more rural and town-less. It has been suggested
That the monastic settlements of the early medieval period presented protourban settlements in which the economic activities of an "urban" class occurred. However, the fragmented nature of Gaelic political authority and the localized and disarticulated nature of economic life prevented the development of anything resembling a market economy. Small Norse trading centers were established by the tenth century, but the Anglo-Norman colonization brought the first market towns in the European mold, with streets and market spaces, protected by walls, lords, and charters. Boroughs and market centers associated with manors were at the forefront of the Anglo-Norman colonial project to attract settlers and establish economic stability, as at port towns like Kinsale, Youghal, Dundalk, and Drogheda, or inland markets like Kells, Trim, Kilkenny, Carlow, and Clonmel. Many of these medieval towns were developed on earlier monastic sites. By the thirteenth and fourteenth centuries a network of towns with market functions had been established in the Pale and the larger lordships of the colony. However, the failure of the colony to incorporate the entire island meant that periodic instability, especially in the borderlands, inhibited the development of the urban network. Towns also became the lynchpins of later British settlement plans: the Laois-Offaly plantation (1556) and the Munster plantation (1586) were based on the implementation of town plans, resulting in the modern towns of Portlaoise (originally Maryborough), Daingean (originally Philipstown), Bandon, and Clonakility; the Ulster plantation program from 1610 succeeded in creating in excess of one hundred towns in the last Gaelic and rural province of Ireland by the 1650s. In the eighteenth century some new market and industrial towns were built with the encouragement of landlords and capitalists to encourage local economic growth, but it was East Ulster in the later nineteenth century that experienced heavy urbanization that resembled that of Great Britain. Apart from a few Bord na Móna villages, urbanization stagnated in the Republic of Ireland in the long emigration phase up to the 1960s. Since then there has been a steady increase in the country's urban population, with growing state investment in the industrialization of the economy.

IV. Case study 2- Grand Paris

(Siting and evolution of cities in relation to regional landscape resources)

4.1 Introduction

"Grand Paris": regional landscape change to adapt city to climate warming

The goal of this interdisciplinary study is to show how city planning changes, wide-reaching and realistic, can be thought out in advance to respond to a variety of aims: landscape, environment for daily life, creation of new economic activities,attenuation of and adaptation to climate change.Such interdisciplinary cooperation is a challenge: not only are the themes considered very diverse but, above all, the scales to be tackled are not at all the usual ones. Architects work at the scale of a building and its immediate surroundings. City planners work on a district or the setting up of a public transport route. But encompassing a whole metropolis—that already exists and carries all its history with it—is something quite new. Posing the questionin connection with climate change is even newer: Indeed, will it be possible, on the scale of a human lifetime, to have an effect on the climate via city planning?

4.2 The Paris metropolitan area

Context, expectations

Among world class cities, Paris holds a respectable rank. The―urban region‖scaleseems to be the most appropriate for an overall approach to the urban issues faced byParis, as shown by the examples of other European metropolises like Berlin (Groß- Berlin) and London (Greater London). In 2008, the French Ministry of culturelaunched the―Grand Paris‖consultation. Ten interdisciplinary teams, each bringing together architects, city planners, engineers and researchers, responded and made urban planning propositions. The Descartes group, led by the architect and urban planner Yves Lion, is one of the ten interdisciplinary teams, and was initiallyspecifically built for this consultation. The authors all participated to the Descartes group. The objective of the―Grand Paris‖is to propose general guidelines for Parismetropolitan area evolution by 2030.The aim is no longer to urbanize but to humanize, no longer to lay out boulevards and build fortifications but to think about a complex, multiple, living, evolving entity. Its complexity must be apprehended from the point of view of sustainable development, the priority for the future.Paris is a capital founded on a situation rather than on an exceptional site. It has no sea, no mountains, no strong topographical contrasts, but a river flowing throughrich farmland and forests. The landscape analysis performed by the Descartes group) describes how Paris, in its double ring—non continous at present—of forests is interwoven with 6 rural regions having their own typical landscapes. The urban tissue began to grow up on these broad geographical features, followed by the star-shaped network of Haussmann's boulevards (19th century) that gave Paris its specific, complex and segmented character. The Paris metropolitan area developed later, particularly during the period of strong economic growth after the Second WorldWar (1945–1973), when certain undertakings (wholesalemarket, facilities, large build-ing projects,...) were moved out of the capital and new forms of rapid transport were set up: airports, suburban railways and the high speed train.The urban area of Paris is home to a population of 11 million at present. Two million people live in the city itself and 9 million are spread over the 1,500 towns and villages that make up the suburbs. However, the 1,500 or so mayors lack the authority (of population or political influence) to be able to take any real initiatives (Gilli and Offner2009).

The policy of forming an integrated metropolis, inaugurated as early as the end of the 19th century byGreater London and the New York metropolitan area, and followed by Groß-Berlin in the early 20th century, has not been assimilated by Paris.Conceiving the metropolis of the 21st century is already an extremely difficult task initself. Applying these ideas to the Paris urban area is another sizeable challenge. Putting life back into the city centre, bringing people back into the heart of the capital will be nothing short of the architectural and town planning revolution of the 21st century!

Fig. 1 Paris geographical situation. Paris has built up on the plain, growing outwards from the River Seine **a** Paris and surrounding plains and forests (in background), **b** River development, **c** area of individual houses typical of the inner suburbs

Fig. 1 Paris geographical situation. Paris has built up on the plain, growing outwards from the River Seine **a** Paris and surrounding plains and forests (in background), **b** River development, **c** area of individual houses typical of the inner suburbs

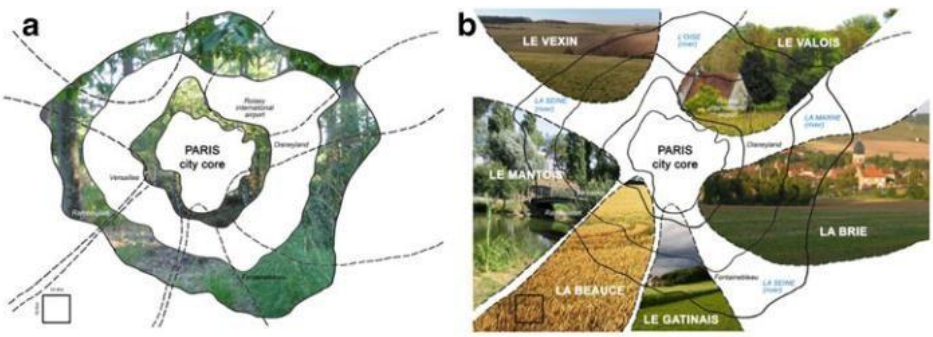


Fig. 2 Landscape analysis of the Paris region. **a** double ring of forest. **b** the 6 agricultural zones forming the basis of the future agricultural parks

4.3 Descartes group's proposal

With the ambition to improve the ordinary daily life of the people of the Paris metropolitan area, based on certain theoretical investigations that have already been undertaken, such as the studies on the dynamics of global cities (Sassen1991) and the future of urbanized areas(Sieverts2003), the Descartes group makes the proposal to rethink the relationship between city and country, re-planning

the overall urban landscape—tackling economic objectives and leisure activities together—while continuing to adapt the city and suburbs to climate change

4.4 Landscapeandsociety-theforest-water-agriculturetriplet Limiting urban sprawl and rethinking the city's outskirts through their environment The landscape is our common property and everyone should be able to enjoy it. By bringing people to recognize the environmental, cultural, landscape and recreational value of their land, we enable them to know it better, ensure that they respect it and encourage them to share it. In addition, developing forest and farmland areas at the edges of urban development will be an effective strategy for limiting sprawl.

4.5 Towards local farming.

Farmland is generally under threat through being considered as a reserve of land that could be used for other purposes. It is possible to promote local farming. The city of Barcelona, for example, has possessed an agricultural park since 1998. Llobregat park is situated 7 km from the centre of the metropolis and serves as the lungs of the city, lungs that are active,productive and evolving (PAÜl2004;PAÜlandTonts2005). It provides certified farm produce that takes advantage of the proximity of the city. Other agricultural parks have been created in large metropolises (Milan in Italy, Oita in Japan, and the Bois- De-La-Roche agricultural park in Montreal).Food is an important element in a sustainable environment (Tukker et al.2010). Reducing–food miles‖helps to reduce a city's energy footprint (Lang and Heasman 2004), eventhough the production methods (Weber and Matthews 2008) and the type of local distribu-tion (Coley et al.2009) also have to be taken into account. The close links with farming inherent in the French way of life (Pettinger et al. 2008), French people's habit of buying (atleast part of) their food in open markets and the special attention they pay to food quality(Gibney et al.1997; Mennell1996) all contribute to the development of local farming thatrespects a better environment (Lamine 2005; Brown et al. 2009). A consumer in the Parisregion who buys using box schemes his fresh food, such as fruit, vegetables, cheese, meatand cereals, needs a farming area of
250 m2 on average (value obtained from box scheme communities associations data analysis). Thus, at least 3,000 km2 would be necessary if the present population of the city and suburbs were all to become—locavores ‖(an expression coined by J. Prentice).We propose the creation of 6 agricultural parks connected with the various areas converging on Paris (brought out by the landscape analysis, each keeping its own agricultural specificities. Situated within about 60 km around Paris, the farms cover anoverall area of 4,000 km2. The objective of agricultural parks is to promote and organize local farming, as a complement to the current intensive cereal growing, so that the metropolis can be supplied with fresh produce grown locally. More than 80 % of this grain production is exported (Billen et al.2012), thus part of the land dedicated to grain productioncould be used for local type of local distribution (Coley et al.2009) also have to be taken into account. The close links with farming inherent in the French way of life (Pettinger et al.2008), French people's habit of buying (atleast part of) their food in open markets and the special attention they pay to food quality(Gibney et al.1997; Mennell1996) all contribute to the development of local farming that respects a better environment (Lamine2005; Brown et al.2009). A consumer in the Parisregion who buys using box schemes his fresh food, such as fruit, vegetables, cheese, meat and cereals, needs a farming area of 250 m2 on average (value obtained from box scheme communities associations data analysis). Thus, at least 3,000 km2 would be necessary if the present population of the city and suburbs were all to become—locavores‖(an expression coined by
J. Prentice).We propose the creation of 6 agricultural parks connected with the various areas converging on Paris (brought out by the landscape analysis, see Fig.2), each keeping its own agricultural specificities. Situated within about 60 km around Paris, the farms cover an overall area of 4,000 km2. The objective of agricultural parks is to promote and organize local farming, as a complement to the current intensive cereal growing, so that the metropolis can be supplied with fresh produce grown locally. More than 80 % of this grain production is exported (Billen et al.2012), thus part of the land dedicated to grain production could be used for local vegetable production without consequence on the grain supply of Paris.
Fruit and vegetable production could be relocated within 100 km or less from Paris, as it was in the late 19th century (Billen et al.2012). In addition, this would reduce transport distance and associated CO2emissions. Furthermore, grain production use an Intensive application of synthetic fertilizers (that makes this agricultural industry a strong N2O emitter,Schulze et al.2009), and to promote local mix cropping farming would reduce the green-house gases emissions.The agricultural countryside becomes

a social space. The limits are clear. The question ofcity density can then be thought about more serenely.3.3 Living forestsGlobal warming is—very probably‖due to greenhouse gas emissions related to humanactivities (IPCC/WG12007; Meinshausen et al.2009). Forests have a high capacity toabsorb the CO2and other greenhouse gases in the atmosphere (−74 g carbon equivalent/m2/year for European forests (Ciais et al.2008)). As Paris is in a temperate climate zone, itsforests have the advantages of both freely available water and a long growing season(Janssens et al.2005). They can thus grow rapidly and act as effective carbon sinks.We propose planting 30 % more forests. The forests of the Paris region cover about4,500 km2today (i.e. 22 % of the overall surface area). They are mature forests that arehardly exploited and not very productive. The additional 1,400 km2would be planted on reconverted farmland (financial subsidies to be set up). The new forests would be established so as to encourage a green network to grow back again, linking the existing forest areas together. These woodlands would thus partly form a forest belt around Paris and its suburbs whilst interweaving and interacting with the built-up areas. Figure3ashows the present stateof forests in Paris region, and Fig.3e shows the proposed extension and densification offorests: densification of forests in the west, and links between large existing forests in the east and south-east. This would create giant–environmental corridors‖stretching over tens of kilometres, at the scale of the whole region.Moreover, in contrast to the present situation, all the forests could be exploited.Half of the available wood (i.e. 375,000 t/yr) could be mobilized in the medium tolong term to produce wood for building or heating (assuming that new sectors of the economy are opened up together with the appropriate know-how). Agroforestry can also provide a means of favouring short distribution circuits. Both of these strategies for exploiting the forest, although they may limit CO2sequestration in the short term,are very effective in attenuating climate change in the long term by taking the placeof fossil fuels or materials requiring more energy for their production (IPCC/WG32007;Simsetal.2006).

Finally, having leisure activities in the nearby forests wouldlimit the distance covered by city-dwellers, who often travel far at the weekend(Orfeuil and Soleyret2003). For this, city planners must think of facilitating accessto the forests (old or to be planted) by public transport.

4.6 Free access to water The Paris region is watered by a large river and several tributaries that have shaped its site and its towns. However, in the second half of the 20th century, urbanization gradually detached itself from the rivers, either by ignoring them or by investing in new sites far fromthe water courses. It is now a question of letting water regain the place it used to hold in theClimatic Change (2013) 117:769–782773

Fig. 3 "Grand Paris" scenario. The present Paris urban area (**a**,**b**,**c**,**d**) and the scenario proposed by the Descartes team (**e**,**f**,**g**,**h**) (from top to bottom: overview, crops, forests, lakes)

Paris metropolitan area, while reducing the vulnerability of the various spaces to the risks induced by this highly capricious element.Increasing the area of water bodies (by 300 km2) has several aims:

(i) to help to protect against flooding,

(ii) to build reservoirs of biodiversity,

(iii) to ensure sufficient water resources for agriculture (including the new fruit and vegetable production), and

(iv) to develop local leisure and tourism areas for the population.Water quality in general is an issue, either linked to combined-sewage-overflows, ordinary runoff (washing pollutants from roads or roofs), limited water resource or appearance ofnew types of pollution (subject to the new REACH European Regulation on chemicals).

Improving water quality in the whole metropolitan area will mean restoring the urban watercycle, limiting run-off, and encouraging infiltration and evaporation. The Australian concept of—Water Sensitive Urban Design‖(Fletcher et al.2010) is a useful guide here. The banks of the rivers and the new wet areas will be accessible to the population. A variety of possibilities will be developed in these areas, such as walks, swimming, sailing, living spaces,...All the uses and functions of rivers can be integrated into an urban sustainable development project.

Large scale city planning as a lever for adapting to climate change. From considerations that firstly concerned social and city planning aspects, we have built up a global strategy for re-planning the landscape of the Paris region as a whole. This strategy also includes arrangements intended to reduce greenhouse gas emissions (forests, moving from intensive grain to local mixed cropping farming), so as to contribute to the attenuation of global warming.Is it possible to kill two birds with one stone? Will this great landscape effectivelyimprove the local urban climate of Greater Paris and the comfort of the people who live there? Heat-waves, urban heat island and urban vegetation Citys are often hotter than the surrounding countryside. This effect is known as the Urban Heat Island (Oke1982) and was first demonstrated for London by Luke Howard (1818) (Mills2008). A heat island forms when weather conditions are favourable: sunny days followed by clear nights and little air movement. In fact,the night-time heat island is created during the day. In the country, the energy coming from the sun is partly used to evaporate the ground water sucked up by plants through their roots (Grimmond and Oke1991; Changming et al.2002). The vegeta-tion itself thus stays cool. In contrast, materials present in the city—bricks, concrete,asphalt, tiles, etc.—heat up a lot during the day (particularly if they are dark in colour) and act as heat stores. When night falls, the countryside cools quickly by radiating heat directly to the sky. Urban surfaces cool more slowly: whereas they have already accumulated more heat, they lose less energy by radiation (the—canyon‖shapeof streets makes them into—radiation traps‖, the heat radiated being in part intercepted and kept by the urban fabric).This effect is particularly large in dense European cities. Thus the air cools more slowly in the city.The combination of climate warming (3–6° in summer for Paris in 2100 depending on the emission scenario, Jacob et al.2007) and the urban heat island (that can reach8–10° at night for a city the size of Paris) would lead to very high temperatures in the city. Heat-waves like that of 2003 in Europe would become common: in the emission scenario, with an average of 30 days of heat-wave conditions in the north ofFrance (Déqué2007). Limiting the consequences of such heat-waves is a major health challenge (Scott et al.2004): 8,000 deaths were attributed to the 2003 heat-wave

In the Paris urban area (Fouillet et al.2006).Bringing vegetation into the city is thus a possible path towards adapting towns and there are many ways of doing it: parks, trees in the streets, and vegetated roofs.Street trees seem to have their main cooling effect in the daytime (by providing shade) and the effect of a green roof (in isolation) on the air temperature is not certain: Bowler et al. (2010)review‘s states that observations of 125 parks show that the air is cooler in parks than in the neighbouring built-up areas both by day (0.94 °C) and by night (1.15 °C). However, few studies document the extent of the influence of parks. A park of about 150 ha can have an impact up to about a kilometre away in favourable conditions (Upmanis et al.1998) but the influence of two smaller parksstudied was less marked. Although there have been studies on the cooling impact of parks covering a few dozen hectares within the fabric of a city, no-one has assessed the influence that landscape developments of several thousand km2, as envisaged herefor Greater Paris, would have.

Numerical modelling shows—Grand Paris‖decreases the urban heat island by 2–3°CWe use here an original, comprehensive and physically-based numerical modelling framework (Fig.4) to quantify the future impacts of the—Grand Paris‖planning scenario. We are then able to show that the proposed landscape change (forests, local farming, water) coupled to reflective surface coverings

reduces the Paris urban heat island by as much as 2–3°C.Our numerical framework takes account of all the interactions between the rural and urban environments and the atmosphere. The heat- wave of 2003 is simulated by combining the chosen development scenarios (more details in Appendix), numerical models simulating exchanges of energy and water between the surfaces and the atmosphere (ISBA—Interaction between Soil Biosphere and Atmosphere—,for the vegetation, Noilhan and Planton1989;TEB—Town Energy Balance—for the built-upareas, Masson2000;Lemonsuetal.2004), and a 500-m-resolution atmosphere model(MesoNH, Lafore et al.1998). Both surface models take the key processes into consideration (solar and thermal radiation, heating of the air, evaporation and transpiration of various plants for ISBA, 3D shapes of buildings and radiation trapping for TEB, effects of urban materials). The impacts of the proposed planning changes are

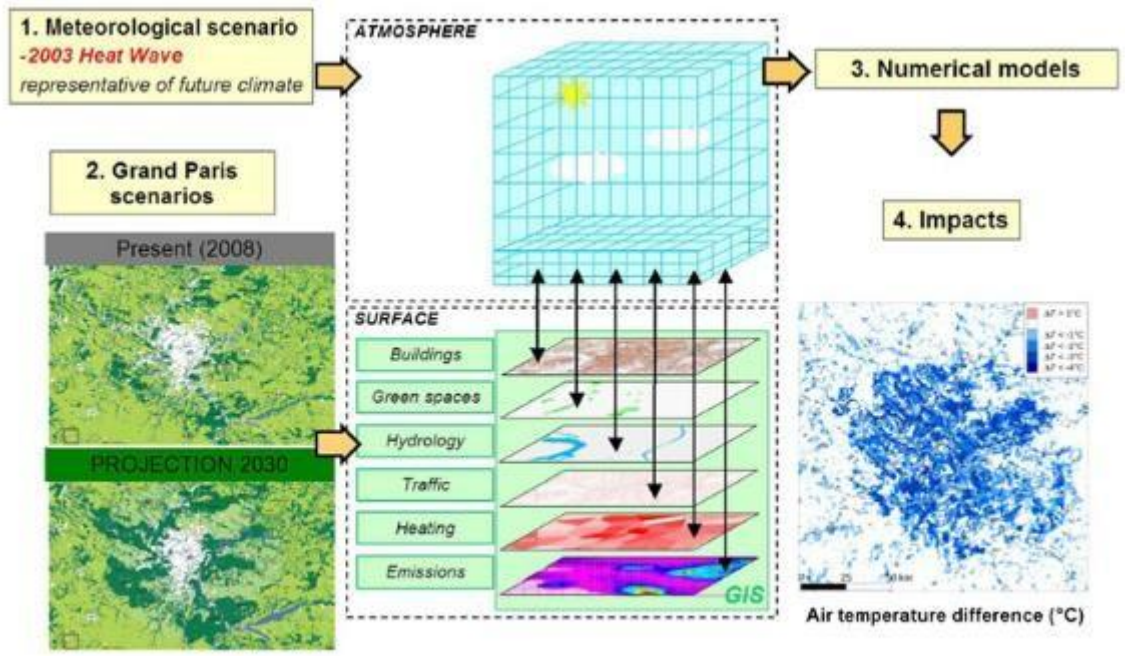


Fig. 4 Methodology developed for the study of "Grand Paris"

deduced by comparing the simulation for present-day Paris with that for the future Grand Paris.In the daytime, the impacts on the air temperature simulated by the models are relatively localized (Fig.5a) and directly related to the underlying change: the temperature is considerably lower over lakes but the cooling does not spread beyond them. The temperature in thecity falls by about 1 °C, thanks to the application of the white paint and the cool roofs on the buildings in the suburban area.At night, the urban heat island reaches about 7 °C, with temperatures of 31 °C inthe centre of Paris. Light coloured buildings also decrease night-time temperature byup to 1 °C (Fig.6), while landscape changes have an even larger effect (2
°C,Fig.7). Then, the proposed combined strategy reduces the heat island considerably(Fig.5b): although the lakes do not seem to influence night-time temperature on the urban-area scale, the strategies of reafforestation and changing farming practices,combined with lighter coloured buildings, lower the night-time temperature by 2–3°C throughout the suburban area, and by 1–2 °C in the historic centre of Paris eventhough no changes are made there. This can be explained by the fact that the air was cooler over most of the urban area and the night breezes brought this cooler air into the centre of the capital.So the large-scale planning of a metropolis, taking not only built up or building land into consideration but also farmed land and natural spaces around the metropolis serves as a leverfor both combating and adapting to climate change. Looking far in time also makes itnecessary to look far in space— beyond the suburbs and even the urban fringe.

4.7 Conclusion

The Descartes group has drawn up an overall strategy for acting on the potential effects of climate warming, from the standpoint of both adaptation and attenuation.Through re-inventing the landscape, we see a new relationship growing up between the city and the natural world, where the surrounding countryside can no longer be considered as a space for the expansion of the city. Short distribution circuits require the development of farming near where the population lives and sustainable exploitation of the forests. Adaptation rhymes with attenuation of climate change impacts. Reaching the optimal urban system requires a combined application of both approaches at all levels of the urban project. In this study, numerical modelling has provided an original, comprehensive and physically-based framework to assess and quantify the impacts of different planning options.It is now up to the operational participants: city planners, politicians and local authorities,to use these ideas to best advantage. Such measures cannot be put into operation instantaneously but their cost, at least in Europe, could be limited—or even cancel itself out—as itwould be covered by a gradual transfer of (existing) farming subsidies from one sector ofagriculture to another.All this induces a—reversal of our point of viewǁ.Upto the end of the 20thcentury, cities were designed mainly through their main driver: infrastructure. Now,most of the infrastructure is in place and the city planning approach of this early 21stcentury is seeking to harness a new driving force, sustainable development. We are now turning our attention to the geographic and natural aspects, inside and even more outside the city, and to the living environment. Working on the city-climate combination leads to a new way of designing the city

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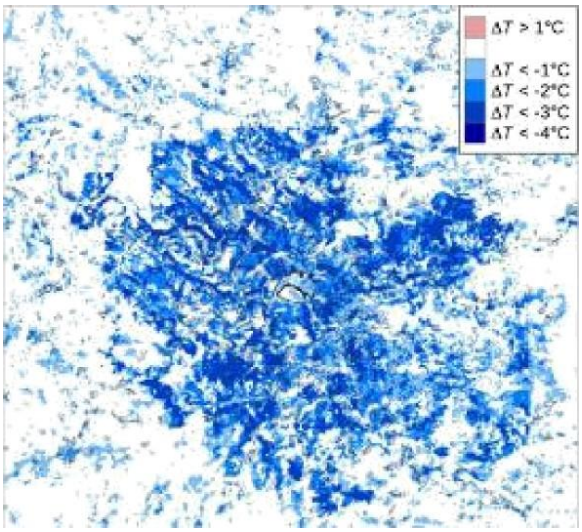

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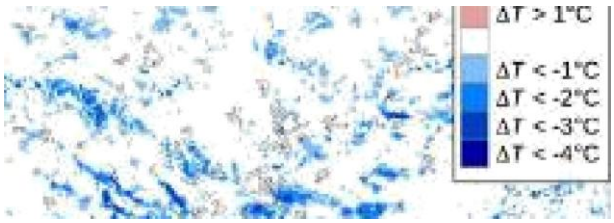

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Fig. 6 Impact of light colored buildings scenario alone. Impact on mean temperatures for strong heat wave event in daytime (12 h–16 h, **a**) and at night (3 h–7 h, **b**). Urbanized areas are displayed as *dark lines*. Temperatures difference (ΔT) (at 95 % confidence level) between 2030 Grand Paris scenario and present Paris are in *color*

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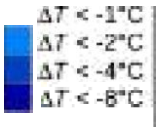

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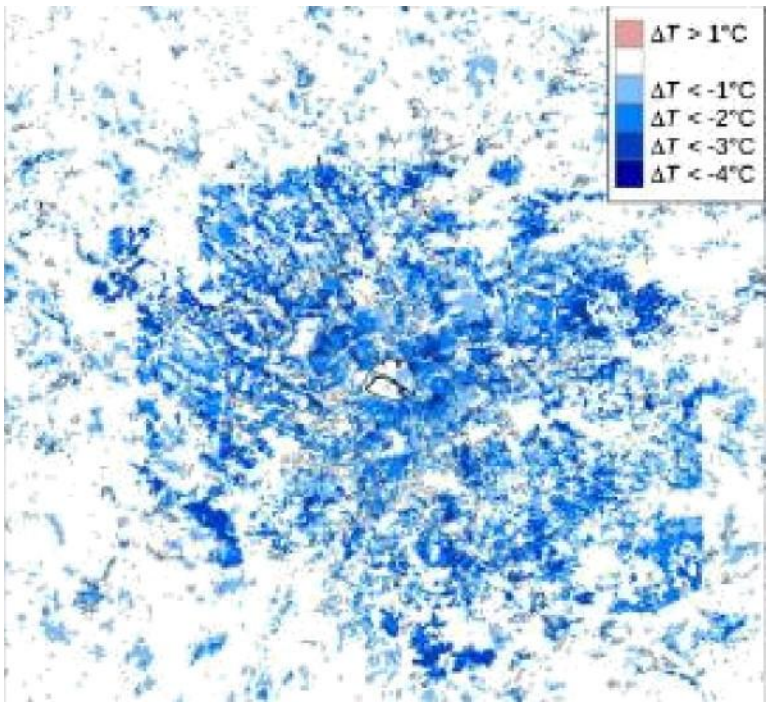
Fig. 7 Impact of landscape urban planning scenario alone. Impact on mean temperatures for strong heat wave event in daytime (12 h–16 h, **a**) and at night (3 h–7 h, **b**). Urbanized areas are displayed as *dark lines*. Temperatures difference (ΔT) (at 95 % confidence level) between 2030 Grand Paris scenario and present Paris



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