



The UNESCO-ITC project



Geo-Information for Environmentally Sound Management of Natural Resources

This demo will provide information concerning the results of the Amboseli Biosphere Reserve pilot area of the UNESCO-ITC project which was finalized in April 1994.

How to operate this demo ?



press Esc at any time to **quit** this demo



press **any other key** for the **next** page

In December 1988 funds were made available to ITC by UNESCO and the Ministry of Education of the Netherlands simultaneously for research purposes. It was decided that these funds would be used for one major research project focusing on the application of Geo-Information Systems. The ecology component of the research project has been designed as case studies to improve the information management of Biosphere Reserves. Therefore, 3 Man And Biosphere reserves were selected:

- CIBODAS B.R., Indonesia
- AMBOSELI B.R., Kenya
- WUYISHAN B.R., China

Schematic representation of the Man And Biosphere reserve zonation:



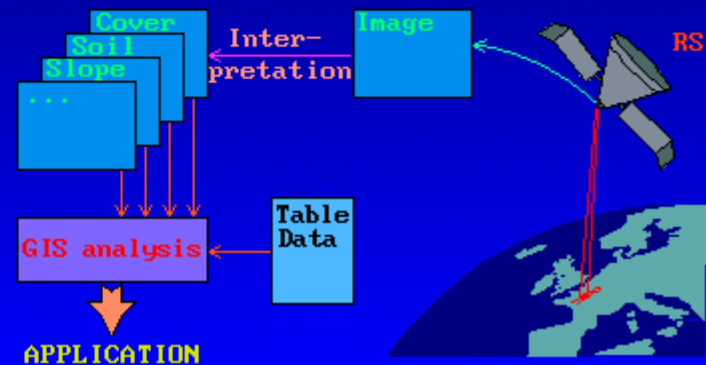
- Core Zone** Is strictly protected with well defined conservation objectives
- Buffer Zone** Is the area (in ideal circumstances) completely surrounding the Core Zone, where various human activities may take place as long as they do not impinge on the Core Zone.
- Transition Z.** surrounds the core and buffer zone, in which the development function of the resource base is emphasized, considering the need for sustainability of utilization.

Within the General frame work of the MAB programme, the UNESCO / ITC project aims at the improvement of resources management structures and procedures by introducing the possible role of modern technologies (GIS and Remote Sensing) to support decision making in the context of resources management.

More specifically, the objectives of the project are:

- to develop a methodology for the design, the introduction and the operation of an interactive and dynamic GIS for the management of natural resources.
- to transfer this methodology to specialists from various levels and sectors of management and research.

Schematic representation of the application of Remote Sensing (RS) and Geographical Information Systems (GIS):



Large scale tea plantations, yielding large quantities of fuelwood



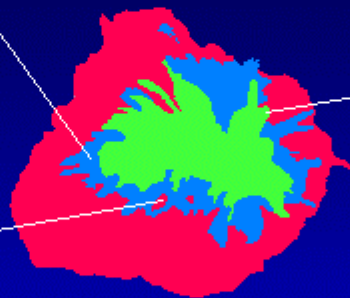
Illegal fuelwood collection

Illegal fuelwood collection in the National Park (core zone) of the Cibodas Biosphere Reserve, can often be explained by the agricultural shift which is taking place.

For example, large scale tea plantations (buffer zone) are being converted to economically more attractive cash crops, yielding less fuelwood and introducing human activities closer to the National Park.

Since alternative energy like kerosine is expensive, the shortage in fuelwood is in many cases compensated through illegal fuelwood collection, resulting in degradation of the forest.

shift



economically more attractive crops, like onions, yielding less fuelwood



resulting in

compensation of fuelwood shortage by illegal fuelwood collection





Cibodas Biosphere Reserve



The first pilot area (Cibodas Biosphere Reserve, West Java, Indonesia) was completed in April 1993. The biosphere reserve consists of a National Park (primary rainforest on the slopes of a twin volcano), partly surrounded by a buffer zone (tea plantations and production forest), which again is surrounded by intensively used agricultural area.

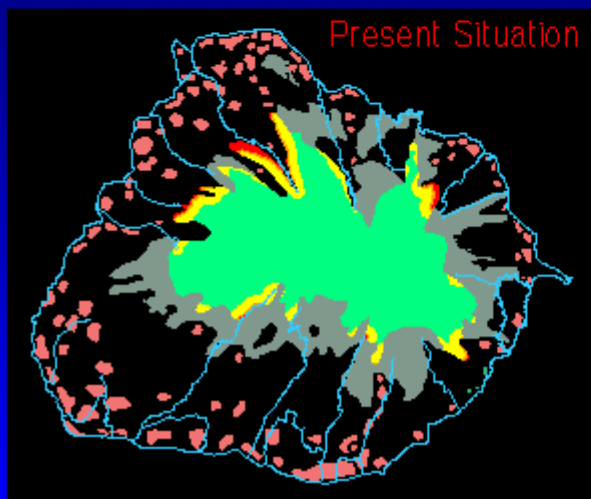
To sustain in their daily demand for energy, fuelwood is used which is produced by the land uses practised in the area. Gradually, there has been a shift from fuelwood producing land use types (e.g., mixed gardens and tea plantations) to land uses which are economically more attractive (cash crops), but producing less fuelwood.

Since alternative energy is expensive, the deficiency in fuelwood is often compensated by illegal collection of forest products in the park, resulting in degradation of the forest.

For this project a dynamic expert system ISM (Interactive Spatial and temporal Modelling) has been developed, to estimate the location and the extend of the expected impact in the National Park.

The ISM expert system presents clear output in maps and tabular data, and enables the manager to evaluate the management scenario before taking it into practice.

- National Park, no impact
- Medium impact
- Severe impact
- Buffer zone
- Shortage village
- Surplus village
- Infrastructure

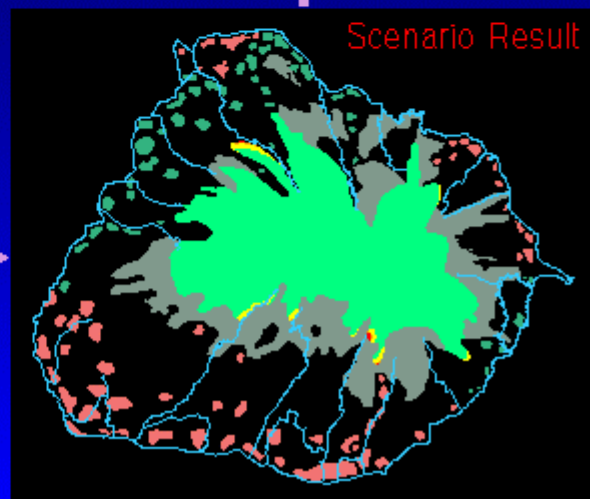


Management Scenario

ISM

Expert System

Feedback





Amboseli Biosphere Reserve



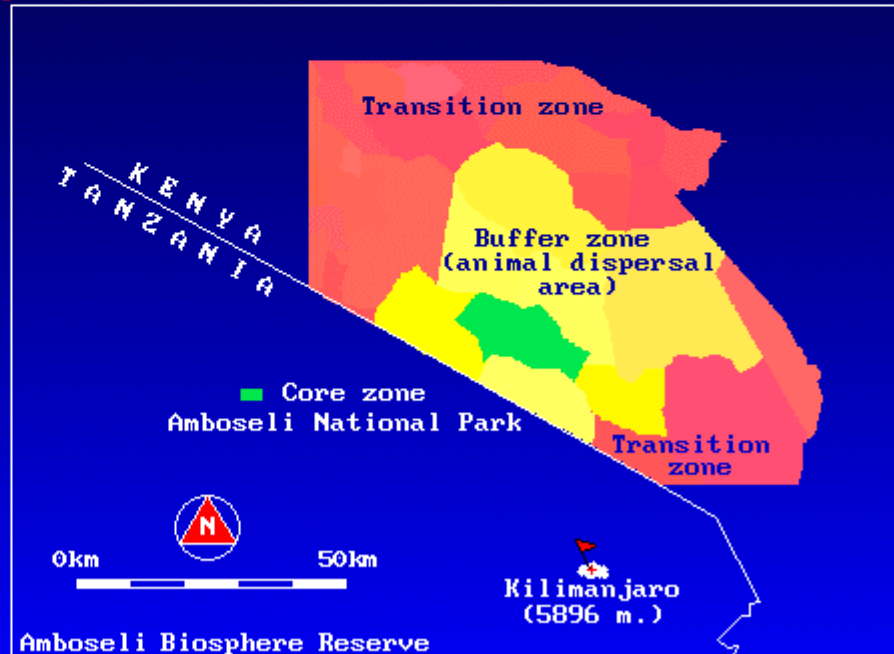
International Institute
for Aerospace Survey
and Earth Sciences (ITC)



Kenya
Wildlife
Service (KWS)



United Nations Educational
Scientific and Cultural
Organization (UNESCO)



Amboseli Biosphere Reserve



Amboseli is a typical example of a semi-arid savannah ecosystem in eastern Africa. The availability of forage and water is highly seasonal, which has an important bearing on the wildlife and the Maasai's livestock.

The core zone contains springs and swamps where most wildlife concentrate during the dry season. The buffer and transition zones are the grazing areas of traditional Maasai pastoralists; it is also the dispersal area of the wildlife of the Amboseli ecosystem during the wet season.

MAASAI: *lifestyle and culture*



Pastoralists are people who derive most of their income or sustenance from keeping domestic livestock in conditions where most of their livestock feed is natural forage rather than cultivated fodder and pasture. The Maasai, who are the traditional inhabitants of the Amboseli ecosystem, are nomadic pastoralists.

Cattle is the main livestock type though very often supported by sheep and goats. The main produce types are milk and meat though blood and skin are also produced. Apart from occasional sales of cattle, the produce is basically for subsistence. Other uses of the livestock and/or livestock produce includes gifts and traditional ceremonies. Each homestead keeps a couple of donkeys mainly for transport.

Two factors dominate pastoralists use of the land in arid areas i.e. rainfall variability and intra seasonal difference in relative productivity. Pastoralists respond to these factors by flexibility of risk spreading and mobility of livestock and people. Risk spreading includes keeping large herds and different species of livestock. The Maasai and their livestock respond to the erratic climate by converging near permanent water sources in the dry season, whereas in the wet season they disperse to areas with better pasture.

Livestock numbers are very often depending on the climate, with numbers building up in times of adequate rain and decreasing when there is drought. The rangelands, which are divided in group-ranches, belongs to all the community members (of each group-ranch) thus every body has equal rights to the lands.

Before 1968 there was no form of group ownership in Kenya. In 1968 a new land adjudication Act made provision to enable a group of individuals to be registered. The group-ranch concept was introduced in Maasai land in the early 1970's, the first in 1972 (Kimana group ranch). It was designed to replace the traditional nomadic system without conflicting the original practice. Though the members hold a collective title deed, the animals are owned and managed individually.



Problem Identification

After analysis of the information, acquired during the workshop held with various parties involved in the management of the Amboseli Biosphere Reserve, combined with the research done by various MSc students and other relevant information and literature, the following main fields of conflict were identified:

▪ Competition between wildlife and livestock for forage and water

Since Maasai tend to go into the Park for water and forage (picture 1 & 2) during the dry season, and wildlife migrates to Maasai rangelands during the wet season, conflicts are likely to occur.

▪ Increase of agricultural activities

When irrigated agriculture (picture 4) is implemented in the buffer and transition zone, traditional migratory routes of wildlife can be disturbed, leading to harassment and crop destruction. Furthermore, the year-round irrigation, might affect the groundwater tables.

▪ Subdivision of the group ranches

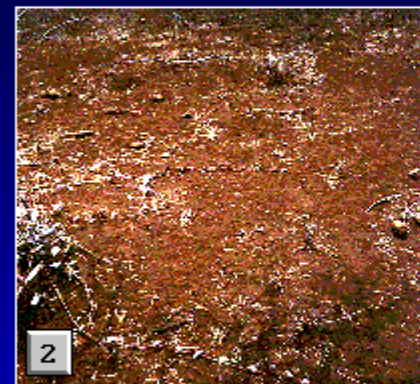
Subdivision of group ranches, may lead to selling of plots, agricultural practices, fences may be erected (picture 5), all affecting the migratory routes of wildlife.

▪ Tourist activities

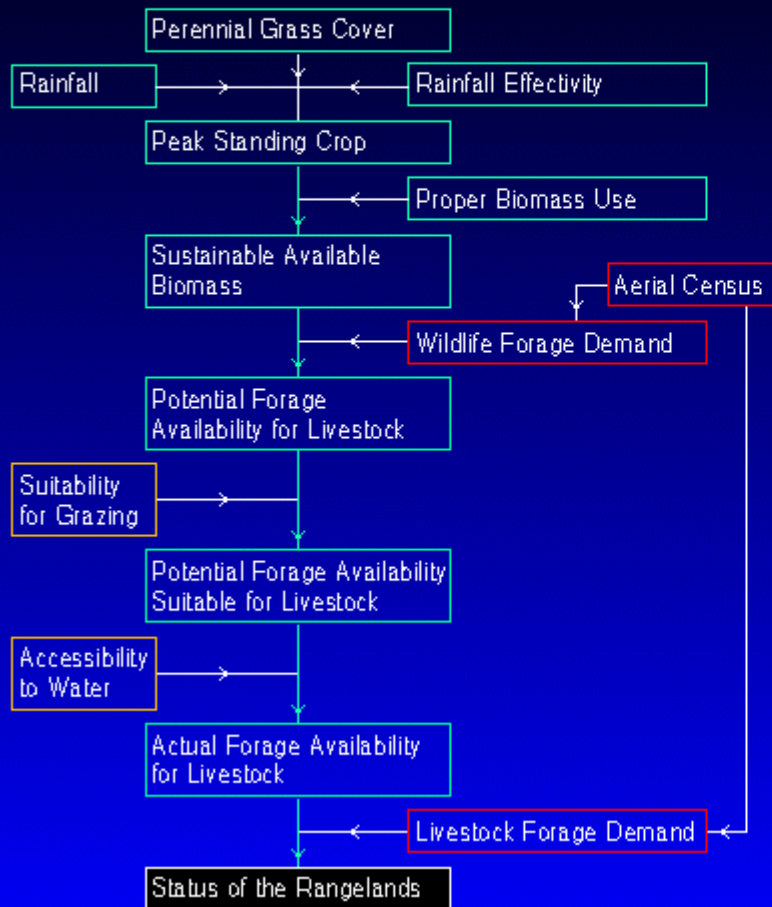
On average, some 15.000 tourists visit the core zone each month, causing harassment of wildlife and degradation of vegetation (off road driving).

▪ Other problems

A selection of the other problems which were identified during the workshop are; soil erosion (picture 3), revenue sharing, increase of human population, land tenure and lack of management policies.



Model Building



One of the major problems identified was the competition between wildlife and livestock for forage and water. Since this problem is related to many other issues mentioned in the section '*Problem Identification*', it was chosen as the 'key' issue in the development of the Interactive Spatial and temporal Modelling (ISM) program.

To be able to construct this model, which is calculating and displaying the spatial and temporal variation of the theoretically expected impact of the grazing activities of both wildlife and livestock in the Amboseli Biosphere Reserve, data has to be collected concerning animal distribution and density per wet and dry season, the Maasai herding strategies, wildlife migratory routes, the biomass production of various land cover types, data concerning the water availability during the dry season, rainfall data, etc.

The model consists of three parts (see simplified model on the left):

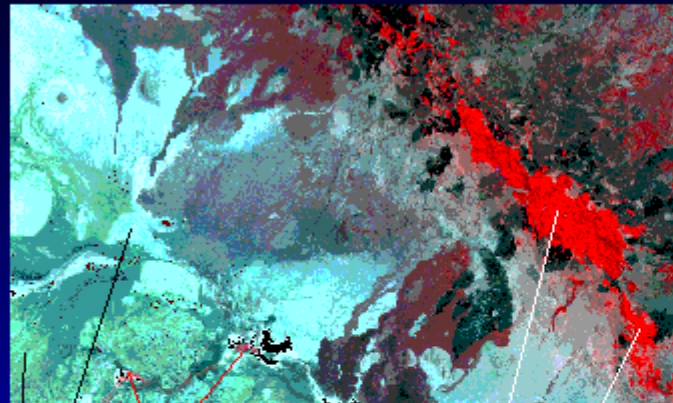
- Green box - location and extent of the forage **availability**
- Red box - location and extent of forage **demand** by wildlife and livestock
- Yellow box - **accessibility** to forage

The forage availability is in fact the productivity of the rangelands under certain climatological and biophysical conditions.

The forage demand is related to the distribution and density of both wildlife and livestock during different periods (e.g., dry- and wet season).

The accessibility is a matter of the available drinking water, for especially the water dependent wildlife species and livestock during the dry season, but also other aspect like topography and surface roughness play a role.

The use of satellite imagery for preliminary land cover assessment



Permanent swamps with
Cyprus sp. vegetation

Rangelands with sparse
grass cover

Chyulu mountain range
with dense forest

part of a false colour composite of SPOT bands 3(RED),
2(GREEN) and 1(BLUE) of 5 October 1991.

Satellites can measure and record the reflectance of electromagnetic energy from the Earth's surface, which is called Remote Sensing (RS). Electromagnetic energy reaching the Earth's surface may be reflected, transmitted or absorbed. Reflected energy travels upwards through, and interacts with, the atmosphere; that part of it which reaches the sensor of the satellite is detected by the sensor and converted into a numerical value, to be transmitted to a ground receiving station on Earth.

The amount and spectral distribution of the reflected energy is used in remote sensing to infer the nature of the reflecting surface.

A RS satellite normally comprises several sensors, each scanning at different wavelengths, producing multispectral satellite imagery.

(Paul M. Mather, 1987)

The GIS used in this project (ILWIS) also comprises an Image Processing Module, able to combine multispectral images into a colour composite, by assigning images from three different wavelengths to the RED, the GREEN and the BLUE band.

Each application (e.g., soil assessment, vegetation assessment, geology assessment, etc.) requires a different combination of multispectral images for the RED, the GREEN and the BLUE band.

The colour composite can be classified into classes with the same multispectral response, however the same response does not necessarily mean the same cover.

For instance, roof-tile reflection can correspond with the reflection of crater lahar, but it is very unlikely to find houses on the top of an active volcano.

Therefore the delineation produced by the program should be combined with other relevant data and verified in the field.

Land cover types in the Amboseli Biosphere Reserve



Amboseli Biosphere Reserve consists of various land cover types, ranging from bare soil, swamps, savannah to ever dense forest.

The dominating vegetation type is the savannah rangelands, which is the main contributor in providing biomass for the herbivore population.



The basic structure of the vegetation can be divided into 3 different layers (e.g., tree-, shrub- and herb layer).

In some cases the tree- or even shrub layer is dominating (see picture in upper left corner), however, in most cases the herb layer (perennial grasses) is dominating in this savannah ecosystem (see picture in lower left corner).

Perennial Grass Cover

Remote Sensing

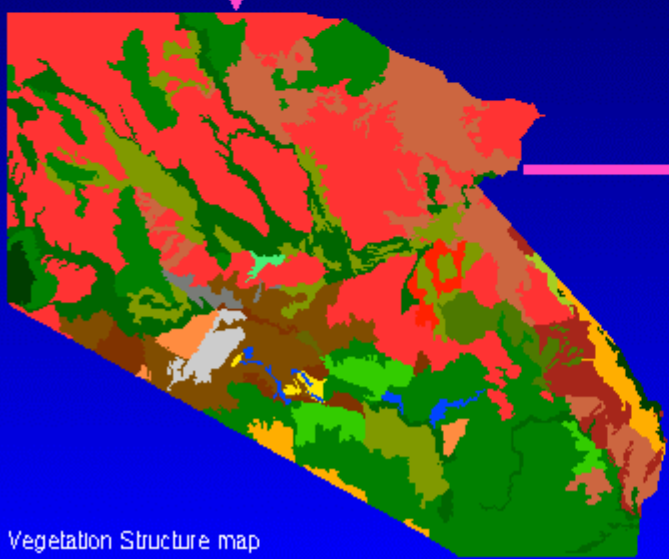
Preliminary Land Cover map

Field Survey

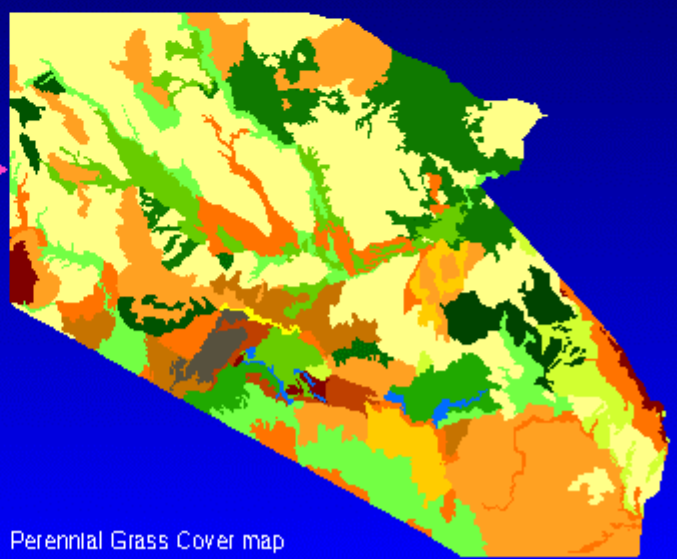
Remote Sensing information (imagery) can be interpreted in order to create a preliminary land cover map.

With the aims of field survey the delineation derived from RS imagery can be used in the field to create a vegetation structure map. This map will comprise information about the tree-, shrub- and herb layer.

Since the perennial grass cover is the main contributor to the biomass availability for the herbivore population (browsers excluded), a perennial grass cover (%) map is derived from the vegetation structure map.



Vegetation Structure map



Perennial Grass Cover map



File Edit Style Graph Print Databa

A1: 'STATIONS'

	A	B
1	STATION\$	Height\$
2	09136039	771.0962
3	09136176	656.8174
4	09136195	774.6591
5	09136190	769.0597
6	09136224	764.6514
7	09137001	759.5996
8	09137003	774.045
9	09137012	695.6277
10	09137028	599.5677
11	09137032	689.2936
12	09137045	792.3314
13	09137056	599.297

Graph Type
Series
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1st Series
Aggregation
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Period
Weighted
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Rainfall Analysis

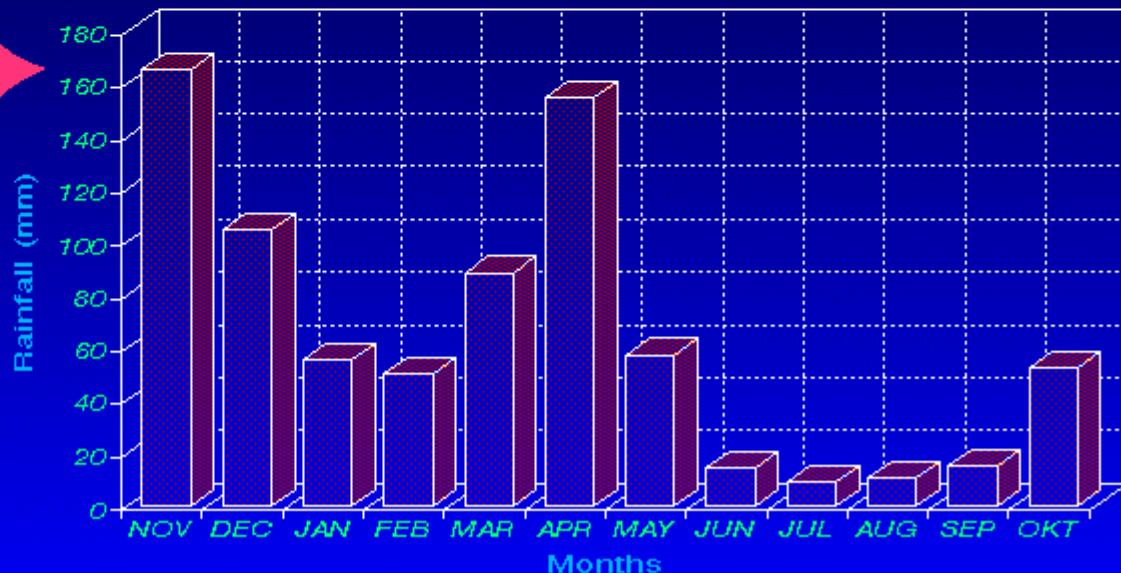
The amount of rainfall is one of the main factors determining the biomass production during the wet season (e.g. the forage availability for the long dry season).

Therefore, data over a period of 30 years from 60 different rainfall stations in and around the Amboseli Biosphere Reserve has been analyzed.

The rainfall data was aggregated to monthly data using databases and spreadsheets, excluding invalid and lacking data.

In order to determine the rainfall seasonality of the ABR and its immediate vicinity, the average long term rainfall was calculated per month.

Average long term rainfall per month for the Amboseli Biosphere Reserve



Bimodal Rainfall Distribution:

Short Wet season Nov-Dec

Short Dry season Jan-Feb

Long Wet season Mar-Apr

Long Dry season May-Oct

Rainfall distribution

To compile the rainfall distribution map for the wet season the rainfall data has to be linked to the locations of the rainfall stations.

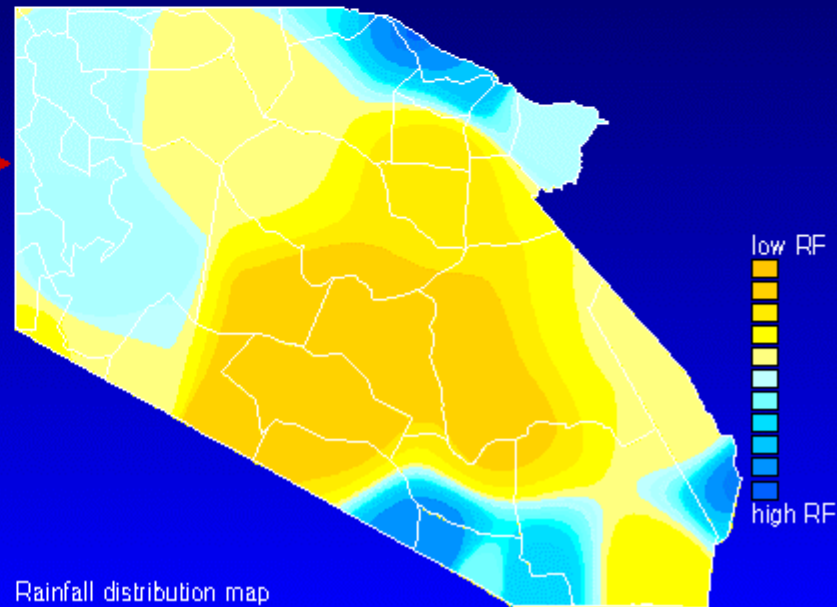
The interpolation procedure, necessary to calculate the rainfall between the stations, is called a gridding operation. Stations, located within a range of 30 kilometres outside the biosphere reserve, are also taken into account to avoid extrapolation errors.

When the new rainfall data entered in ISM is too sparse to create an acceptable rainfall distribution map, long term rainfall data is added based on the deviation defined by the newly added rainfall data compared with the long term data.



Rainfall Stations

Moving Average
Gridding Operation



Rainfall distribution map

Rainfall Data

B4: 'Station





	A	B	C	D	E	
3						
4	Station	X-coord	Y-coord	Rain		
5	09136039	255255	9797229	297		
6	09136176	231147	9799923	393		
7	09136190	245997	9794313	296		
8	09136224	244113	9806433	191		
9	09137001	292340	9809329	323		
10	09137003	344306	9762310	406		

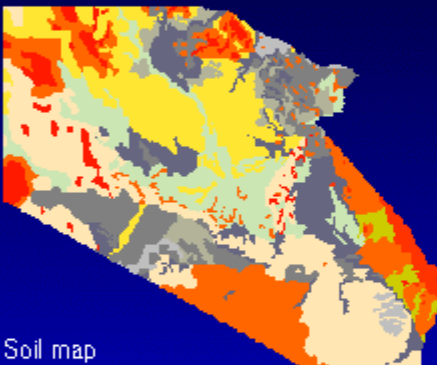
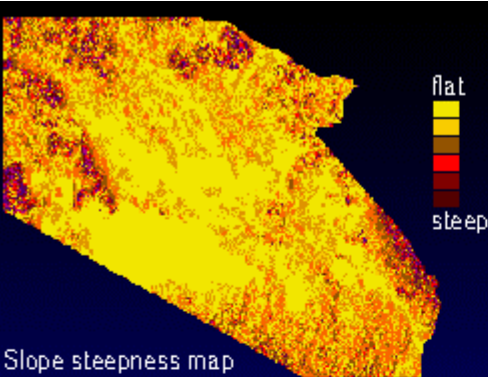
Rainfall Effectivity

The availability of water which can be provided to the vegetation is directly related to the rainfall and the rainfall effectivity.

The rainfall effectivity is a function of the different 'physical' groups defined by a combination of the different soil types and the topography (slope steepness).

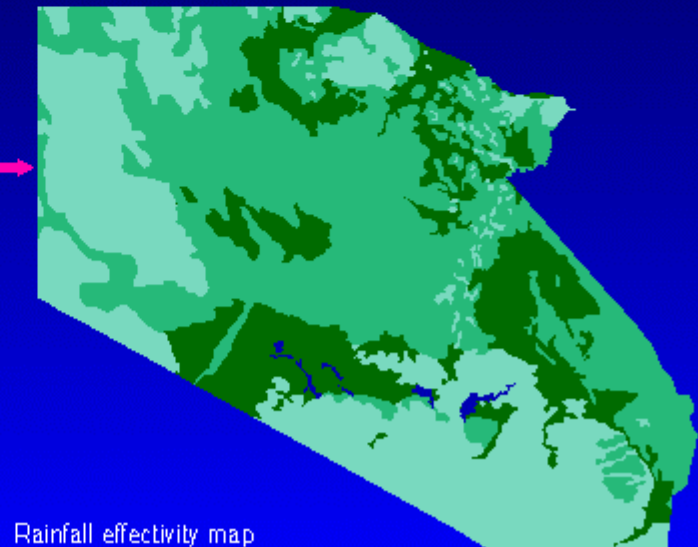
The following 'physical' groups has been distinguished;

-  1. some run-off occurs occasionally
-  2. run-off is rather common
-  3. run-on occurs regularly
-  4. swamp area

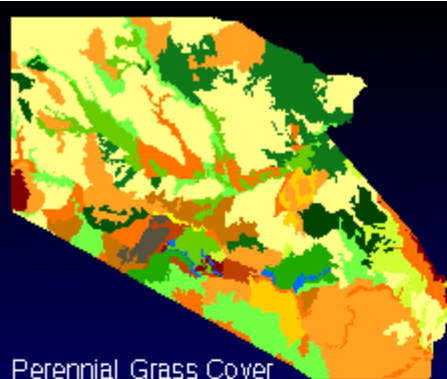


Runoff Values:

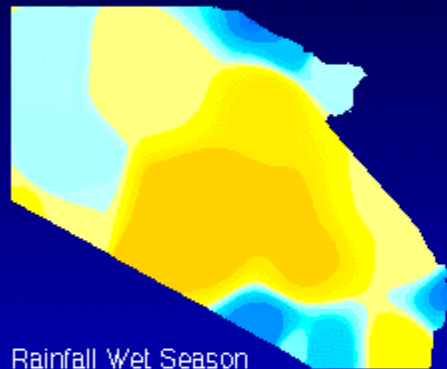
RecNr	Name\$	RunOff%
1	Class 1	0.0137
2	Class 2	0.0059
3	Class 3	0.0120
4	Class 4	0



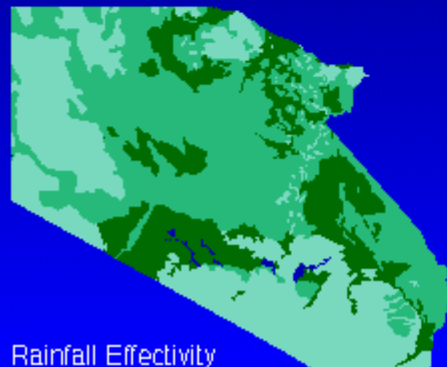
Peak Standing Crop



Perennial Grass Cover

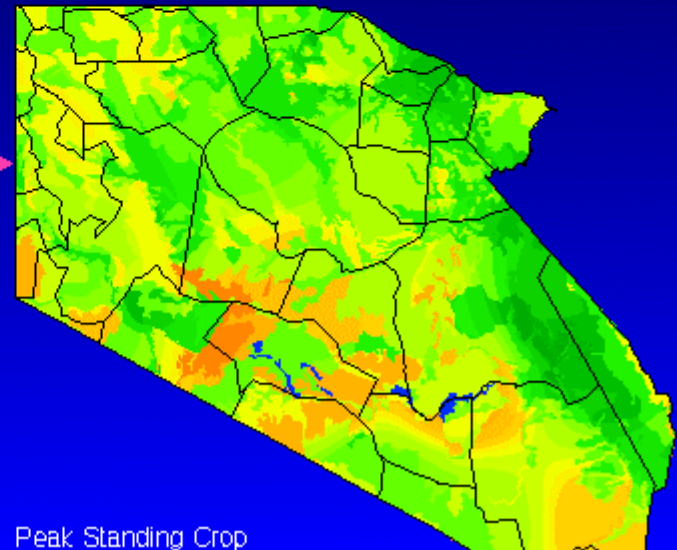


Rainfall Wet Season



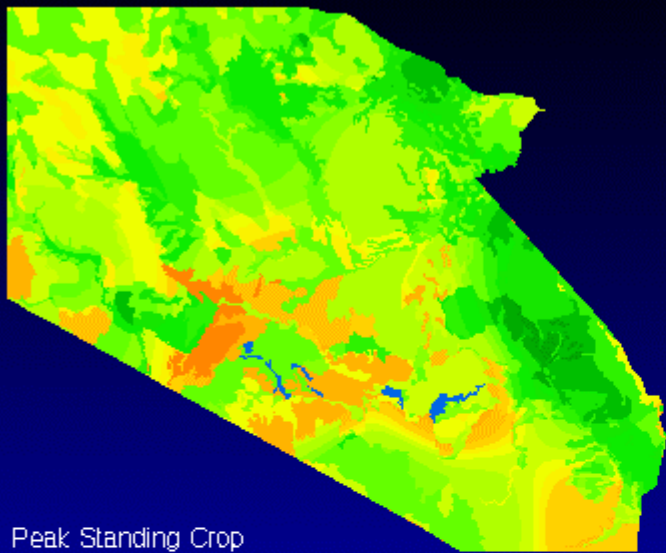
Rainfall Effectivity

When the perennial grass cover is combined with the amount of rainfall and the rainfall effectivity, the peak standing crop can be calculated. The peak standing crop is the amount of biomass based on the perennial grasses at the end of the rainy season.



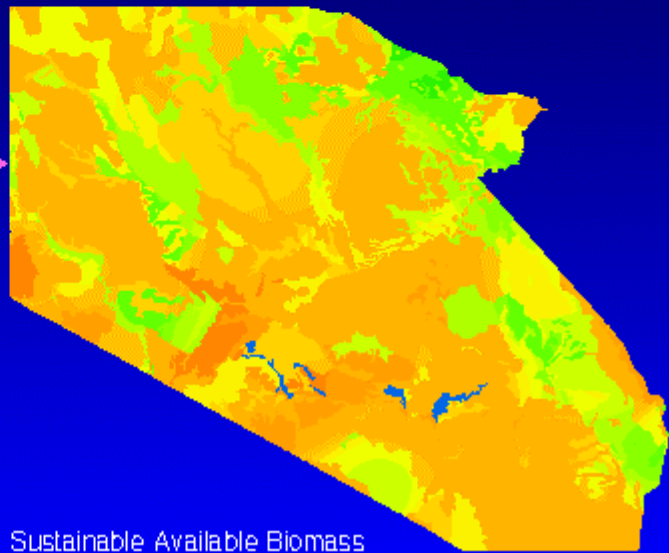
Peak Standing Crop

Sustainable Available Biomass



Peak Standing Crop

To prevent degradation of the vegetation, 45 % of the available biomass (peak standing crop) should be left at the end of the long dry season, 10 % is lost due to natural decay and invertebrate consumption, which leaves 45 % which can be utilized for grazing. This factor containing the percentage of the peak standing crop which can be utilized in a sustainable way is called the proper use factor.



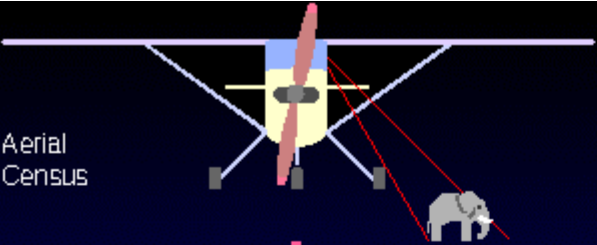
Sustainable Available Biomass

Proper Use Biomass [%]

RecNr	ProseBM#
1	45

Animal Distribution maps derived from Aerial Census

Aerial Census

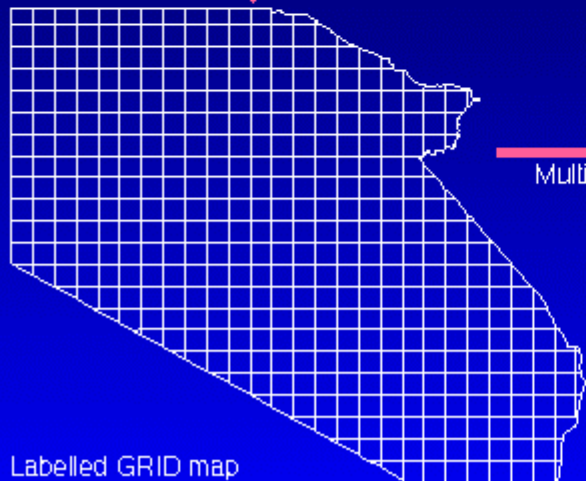


The aerial survey is carried out with an airplane. The plane flies over the survey area, in such a way that it scans each grid cell partly. The counted animals will be recalculated to represent the entire grid cell (5 km by 5 km) and will be stored in a database.

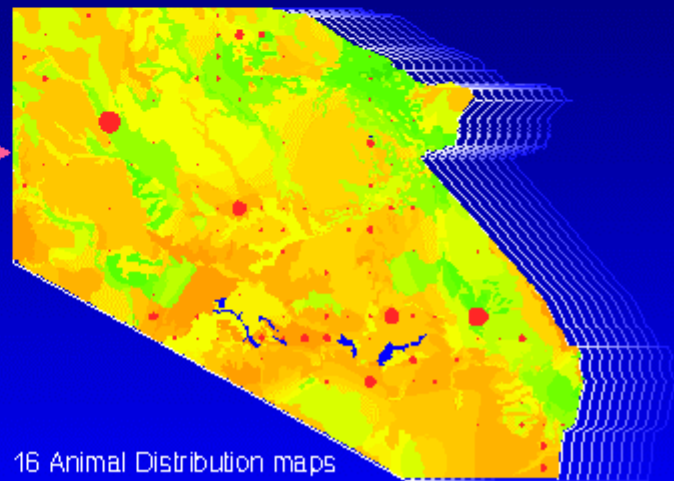
ISM will link the animal numbers in the database using the GRIDCODE as identifier to the labelled GRID map, creating separate distribution maps for each animal of interest (16 grazers/mixed feeders in total). The location of a certain species is indicated with a red circle, the size indicates the number of animals counted.

Database

	A	B	C		Z
1	GRIDCODE\$	CS!	DN!	ZB!
2	70091	240	4	0
3	70092	0	2	34
4	70093	27	8	2
5					

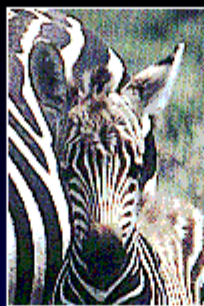


Multiple map generation



Labelled GRID map

16 Animal Distribution maps

**A****B****C****D****E****F**

Wildlife: Grazers and Mixed Feeders

**G**

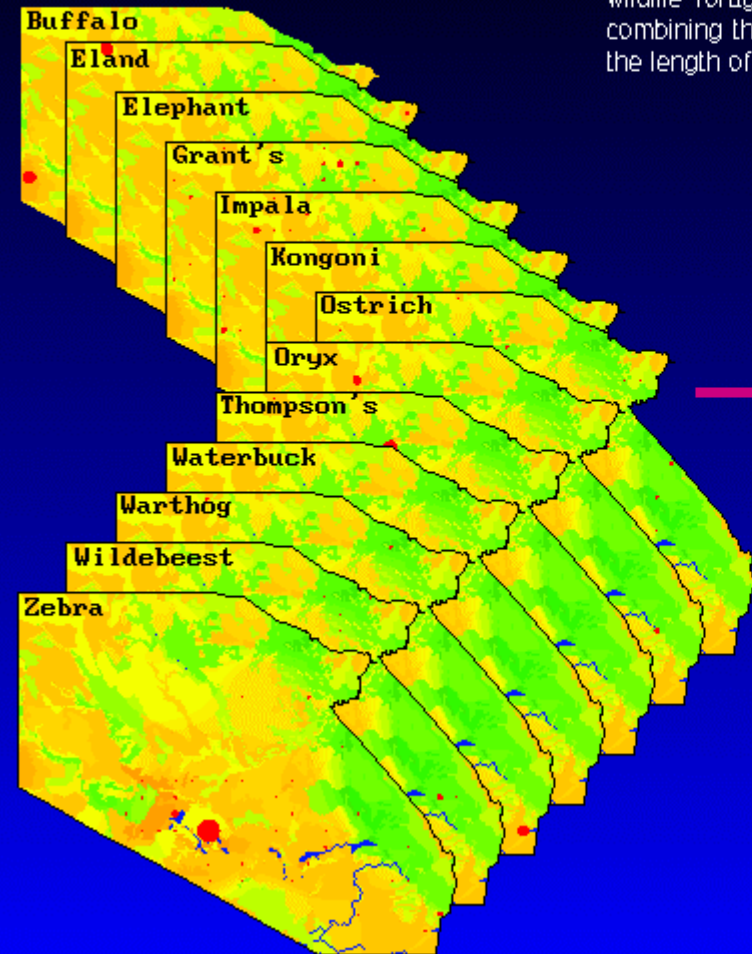
The following wildlife species of Amboseli are taken into account for the calculation of the wildlife forage demand; **A** Elephant (mixed feeder, preference for browsing), **B** Buffalo (grazer), **C** Zebra (grazer), **D** Wildebeest (grazer), **E** Ostrich (grazer), **F** Warthog (mixed feeder), **G** Eland (mixed feeder, preference for browsing), **H** Waterbuck (grazer), **I** Oryx (grazer), **J** Cook's Hartebeest (grazer), **K** Impala (mixed feeder, preference for grazing), **L** Grant Gazelle (mixed feeder, preference for browsing) and **M** Thompson Gazelle (mixed feeder, preference for grazing).

Press Esc to continue with the second part of the demo

**H****I****J****K****L****M**

Wildlife Forage Demand for the Long Dry Season

When the location and density of the wildlife species are known, the wildlife forage demand for the long dry season can be calculated by combining them with dry matter intake values (kg/day) per species and the length of the long dry season.



DM Intake /kg l day]

Name\$	DMl@
Elephant	8.3
Buffalo	8.5
Wildebeest	4.5
Zebra	5.2
Tompson's	0.5
Grant's	1.0
Kongoni	3.0
Impala	0.9
Eland	2.9
Oryx	3.5
Waterbuck	4.3
Warthog	0.7
Ostrich	2.8

Long Dry Months

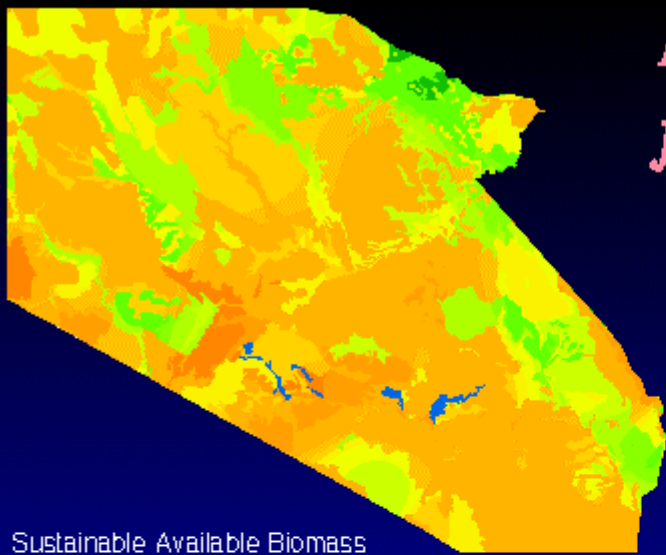
L-DM@
6.000

Wildlife Forage Demand

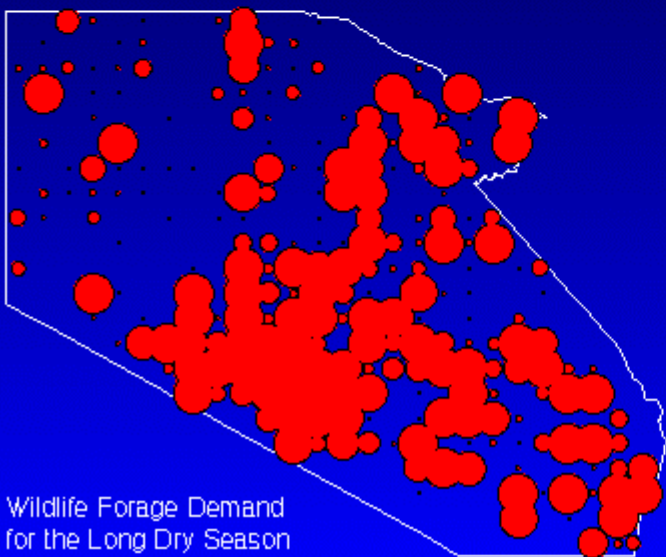
Potential Forage Availability for Livestock

In the model the actual distribution and density of wildlife based on aerial census has been used to calculate the forage demand by wildlife for the long dry season.

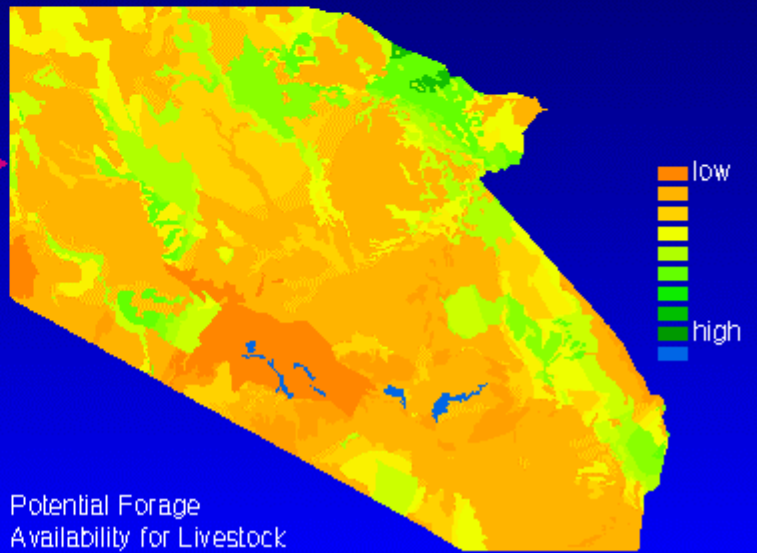
The forage demand by wildlife is considered to have precedence over livestock, therefore first the wildlife forage demand is subtracted from the sustainable available biomass, resulting in the potential forage availability for livestock.



Sustainable Available Biomass



Wildlife Forage Demand for the Long Dry Season



Potential Forage Availability for Livestock



Suitability of the rangelands for livestock

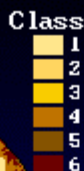
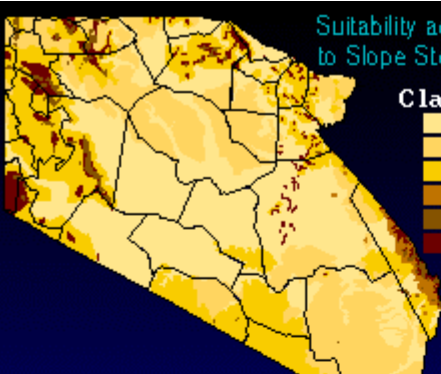


After the calculation of the biomass availability for livestock for the long dry season, the suitability of the rangelands for grazing has to be applied as well to reduce the available biomass from those rangelands, which are not or less suitable for grazing by livestock.

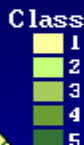
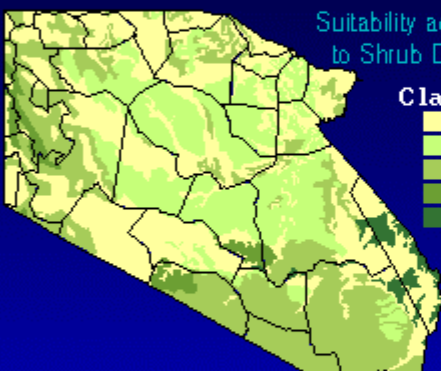
Factors like the slope steepness (picture left top), the vegetation hindrance (picture left centre) and the surface roughness (picture left bottom) will reduce the amount of biomass to what is actually available for grazing by livestock.

Suitability for Grazing

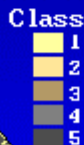
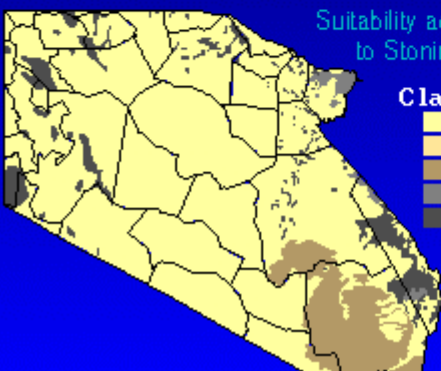
Suitability according to Slope Steepness



Suitability according to Shrub Density



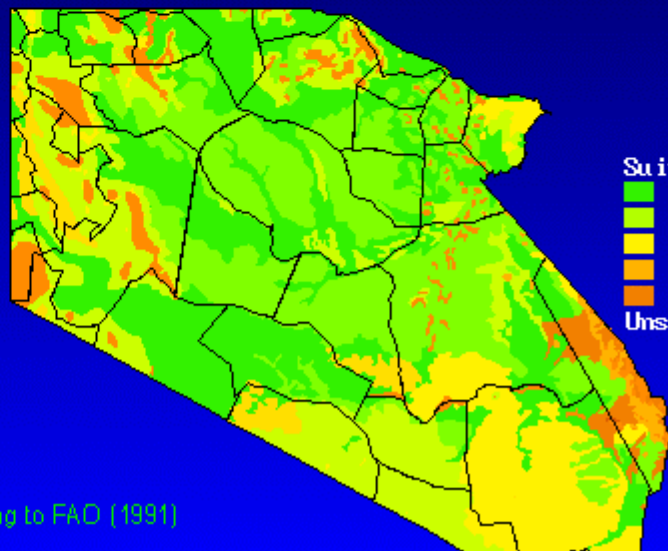
Suitability according to Stoniness



The suitability for grazing is determined by the hindrance due to slope steepness, shrub density and stoniness. When the surface is covered with stones, the shrub density is high or the slope steepness is extreme, livestock will be less able or in some cases unable to utilize the available biomass in those areas.

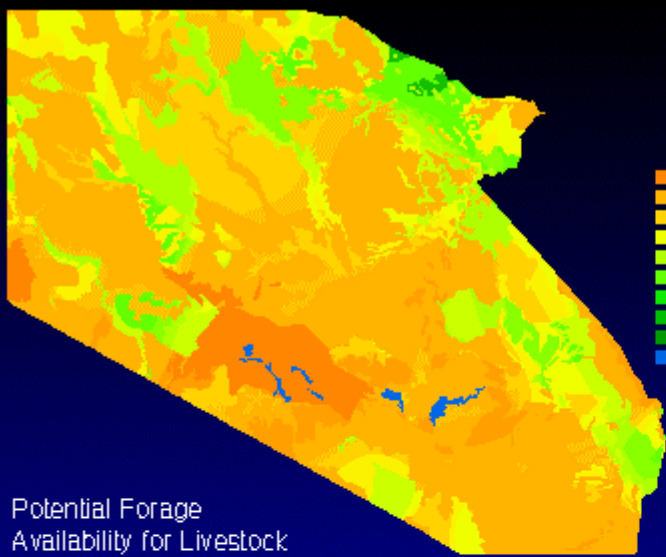
This suitability is used to reduce the potential available biomass for livestock, in order to obtain the potential available biomass which is suitable for grazing by livestock.

Suitability for Grazing



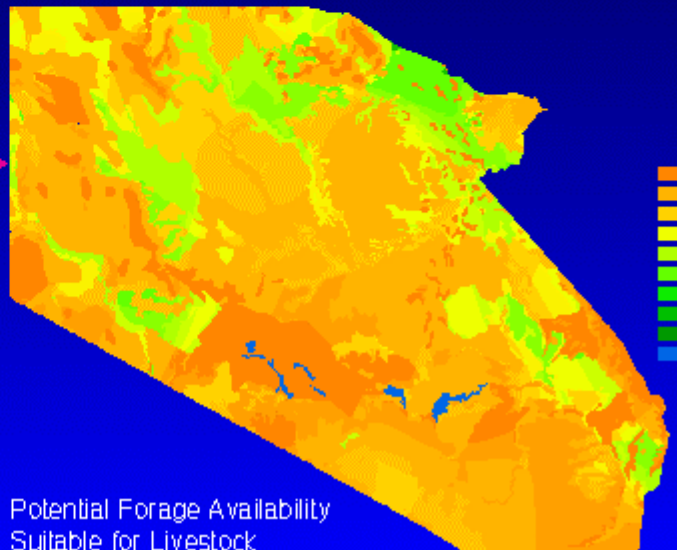
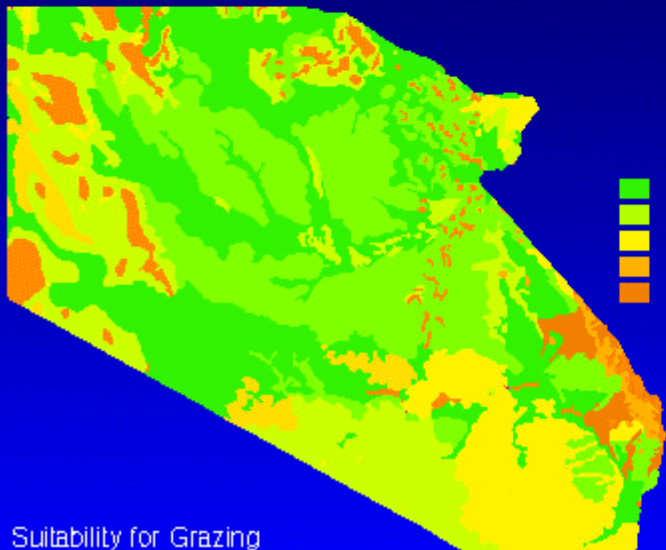
Classification according to FAO (1991)

Potential Forage Availability Suitable for Livestock



Since not all potential available biomass will be suitable for livestock, a suitability calculation is performed including hindrance due to slope steepness, shrub density and stoniness.

This suitability is used to reduce the potential forage availability for livestock to obtain the potential forage availability suitable for livestock.

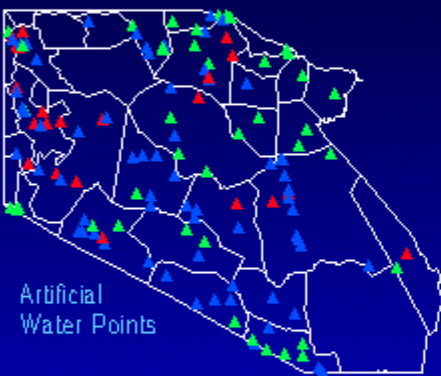
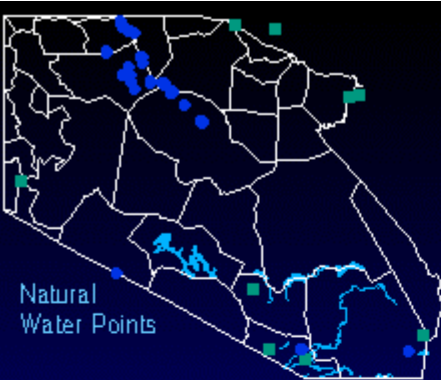


Water Availability

The availability of water is still a crucial point in the herding strategy of the Maasai. The model should be able to develop such a herding strategy to minimize degradation (caused by overgrazing) of the rangelands. Therefore, it is essential to know where, when and how much water is available during the different seasons. The availability of water during the dry season is depending on the existence of artificial water supply; functional boreholes (picture left top), watertanks (picture left bottom), booster- and pipeline water supply and natural water supply; permanent rivers, swamps (see picture right bottom), springs and wells. Estimating the water availability during the during the wet season is not relevant, because water is almost everywhere available due to the many additional seasonal rivers, waterholes, dams, etc.



Accessible Grazing Areas

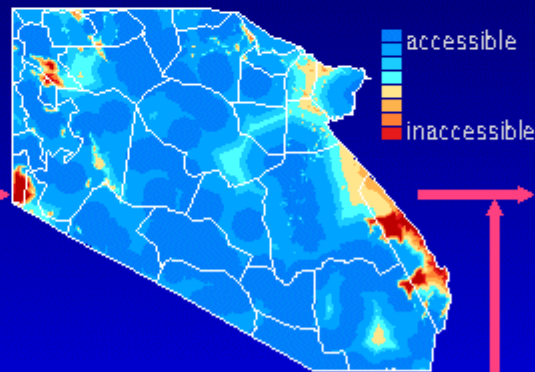


The distribution of and accessibility to water during the long dry season determines for a great deal whether an area can be utilized by livestock for grazing. The accessibility is calculated to the natural and artificial water sources. The natural water sources are wells (■), springs (●), rivers (◁) and swamps (⚡). The artificial water points consist of boreholes, boosters and pipelines, which can be functional (▲), not functional (▲) or dry (▲).

The accessibility also includes the hindrance by cover and slope steepness. Fences occurring in the area, are considered inaccessible.

Weight according to slope steepness and cover hindrance

Fences implemented in the Biosphere Reserve

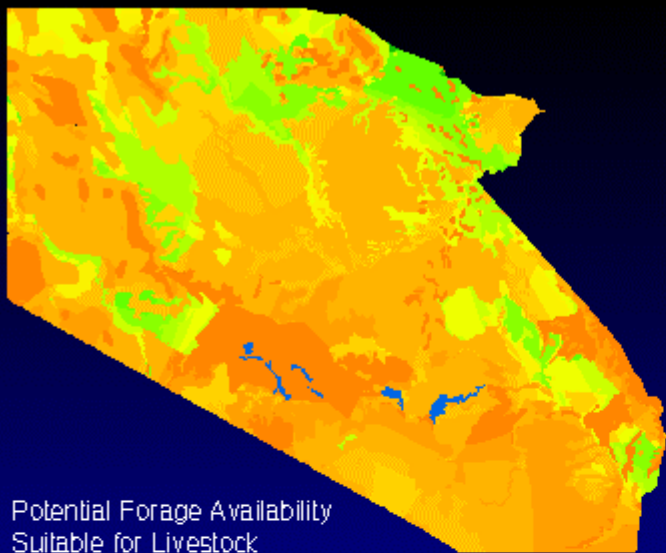


Accessible grazing areas

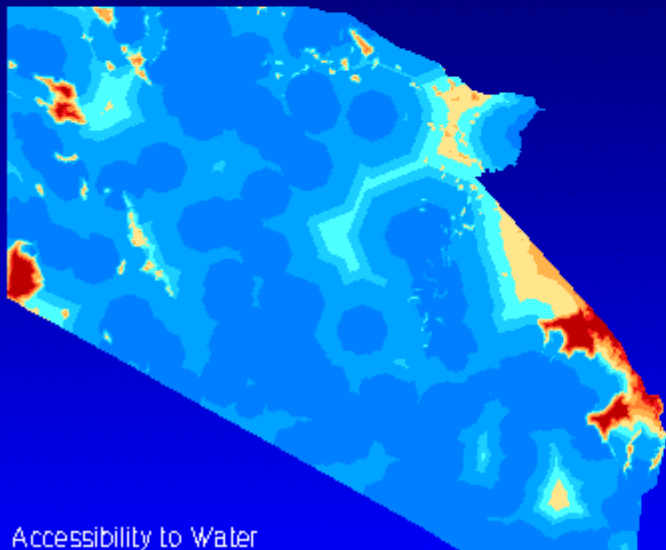
Limiting walking distance for livestock

Actual Sustainable Forage Availability for Livestock

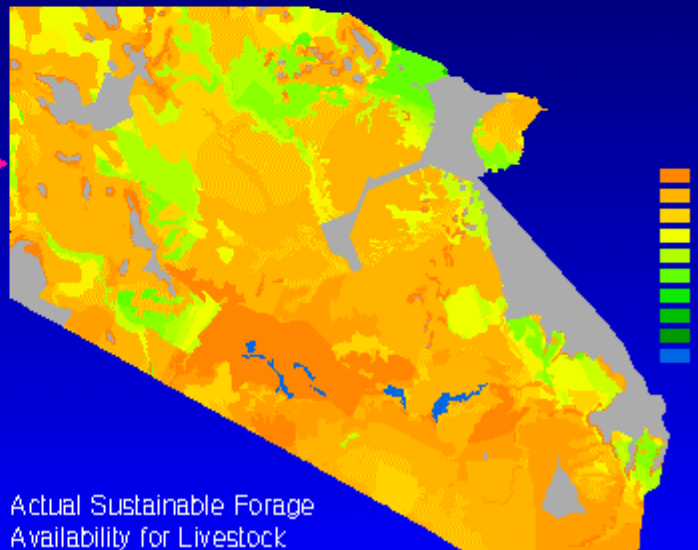
A very important aspect of the grazing pattern of livestock is the availability of water in the dry season or the accessibility to the available water. Livestock has a maximum distance it can walk without water. When an area with a potential forage availability is too far away from a watering point, it is inaccessible and therefore unavailable for livestock. So, in order to determine the actual forage availability for livestock, the inaccessible areas (■) should be excluded.



Potential Forage Availability Suitable for Livestock



Accessibility to Water



Actual Sustainable Forage Availability for Livestock

Livestock



Livestock mainly consists of large herds of cattle (picture left bottom), but also sheep and goat herding (picture left top) is commonly practised.

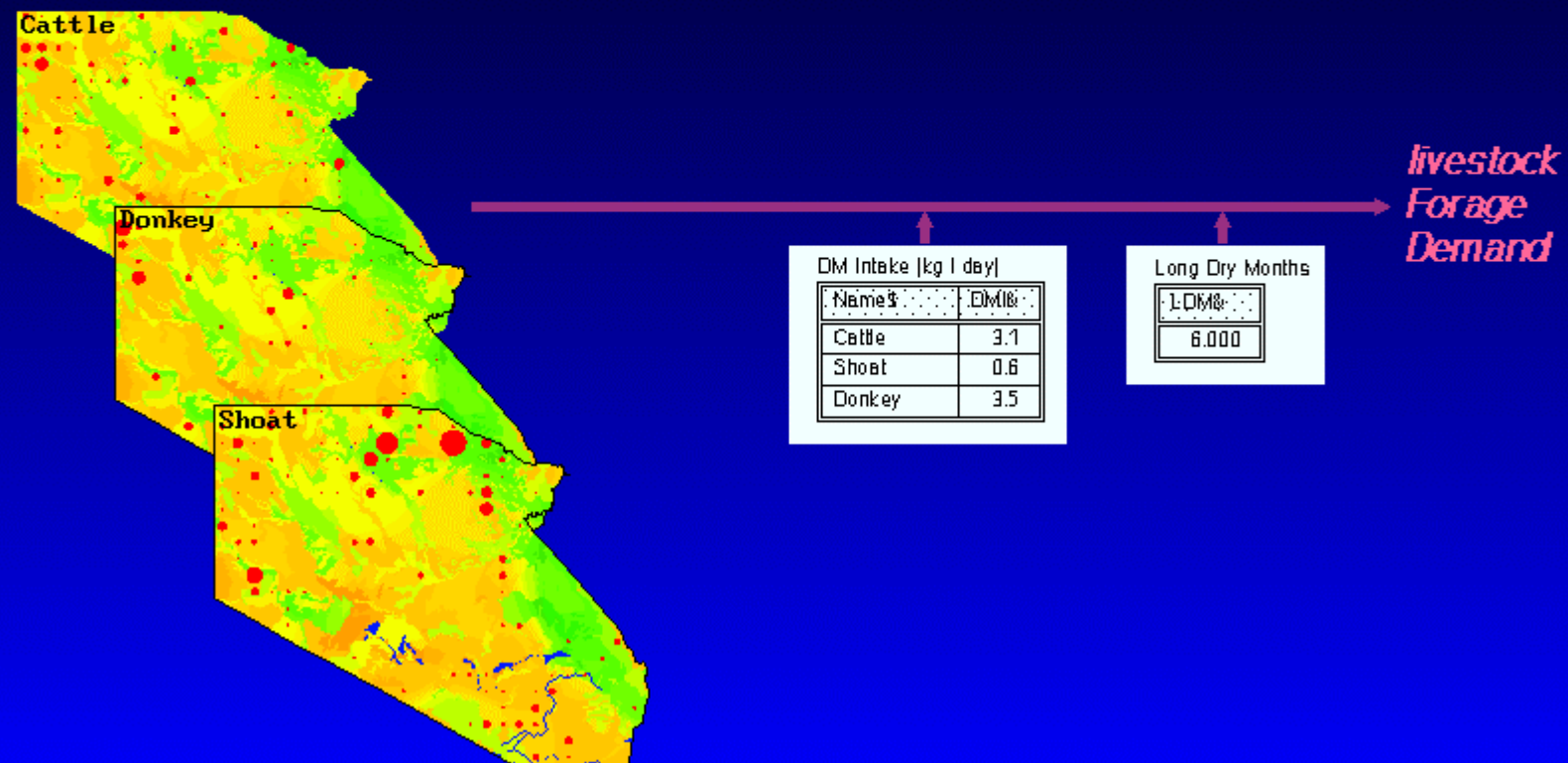
Donkeys (picture left centre) are mainly used for transportation.

Cattle, sheep and goat provide the Maasai in their basic demand for food (e.g., milk and meat). However, nowadays livestock becomes economically more valuable, since cattle, sheep and goat are sold at local markets.

During the aerial survey of livestock, sheep and goat are considered as one species called 'shoat'.

Livestock Forage Demand for the Long Dry Season

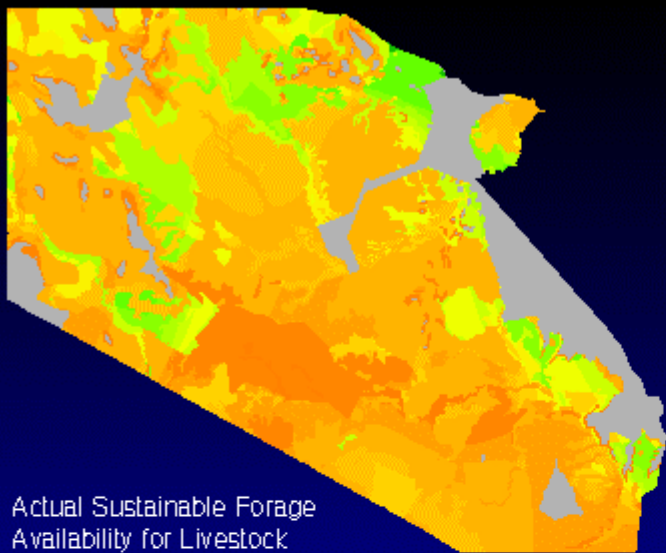
When the location and density of livestock is known, the livestock forage demand for the long dry season can be calculate by combining it with the dry matter intake values (kg/day) per livestock species and the length of the long dry season.



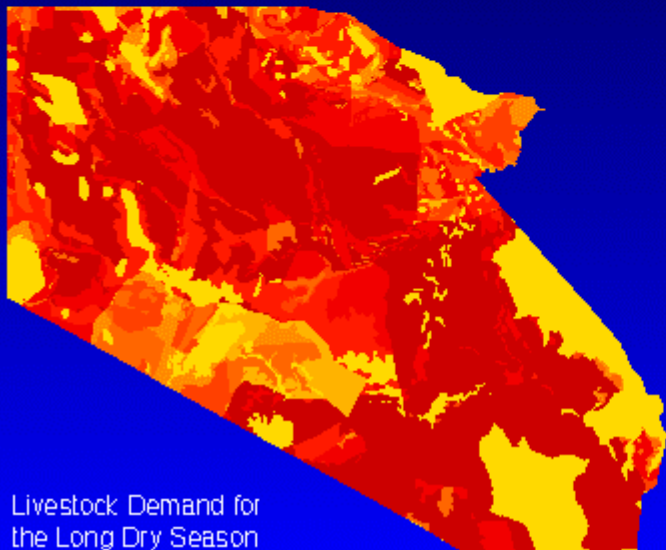
Status of the Rangelands

When the actual forage availability for livestock has been calculated, the livestock numbers are aggregated per group ranch and redistributed over the actual forage availability within the group ranch, assuming that livestock will be distributed according to the actual availability.

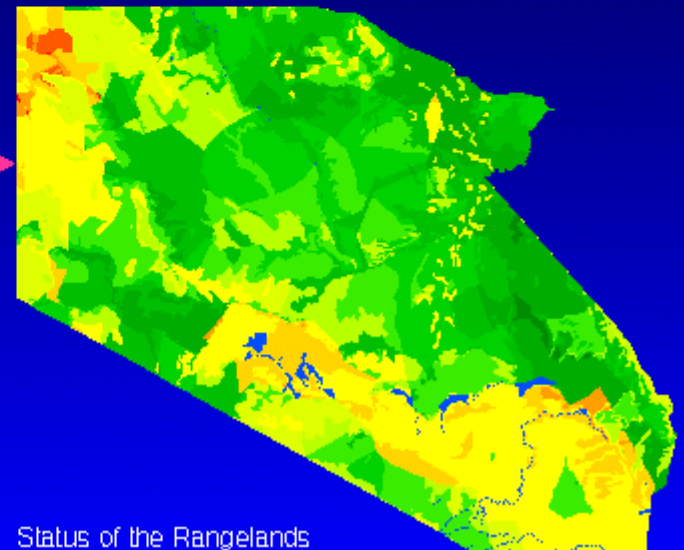
This results in the status of the rangelands, indicating overgrazing (red) and undergrazing (green) based on sustainable utilization of the natural resources.



Actual Sustainable Forage Availability for Livestock



Livestock Demand for the Long Dry Season



Status of the Rangelands

ISM | Interactive Spatial and temporal Modelling

Wildlife & Livestock Distribution

The Wildlife & Livestock maps provide the user with information on the location and the number of animals per species.

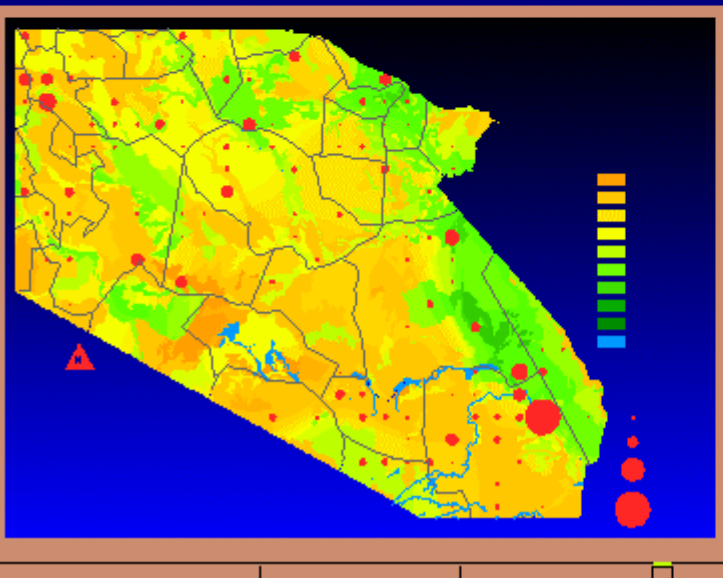
The lower part of the screen shows the schematic representation of the ISM 'Show Result' option for animal distribution. The colour screen (left) will display, using red dots, the location and density of the selected species and the monochrome screen (right) will show tabular information aggregated per group ranch of the wildlife and livestock numbers.

The map which is used as background, represents the sustainable available biomass map. The group ranch borders are indicated using black lines.

When a new census is available it can be automatically imported in ISM. During this process, the new distribution maps, tables and annotation will be generated by ISM.

If a new census has been imported, the Rangelands Management map has to be recalculated for the new situation.

Colour Monitor



Monochrome Monitor

• Wildlife numbers:	• Livestock numbers:
- Elephant	- Cattle
- Buffalo	- Goat
- Zebra	- Donkey
- Thompson Gazelle	
- Grants Gazelle	
- Kongoni (Hartebeest)	
- Impala	
- Eland	
- Oryx	
- Waterbuck	
- Warthog	
- Ostrich	

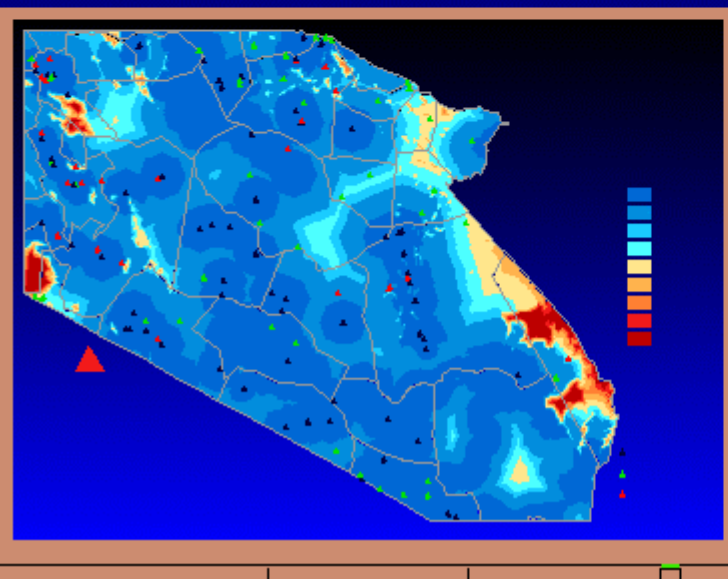
The accessibility to water map, provides the user a clear overview concerning the watering points.

Tabular information about the name, location and status can also be obtained.

The artificial watering points (e.g., boreholes, boosters and pipelines) are indicated with coloured triangles;

- ▲ - functional
- ▲ - not functional
- ▲ - dry

Colour Monitor



Monochrome Monitor

Water point information:

- Water point code
- X-coordinate
- Y-coordinate
- Water point name
- Status (functional, not functional or dry)

Rangelands Management map

The Rangelands Management map provides information on the location and the extent of overgrazing in the Amboseli Biosphere Reserve.

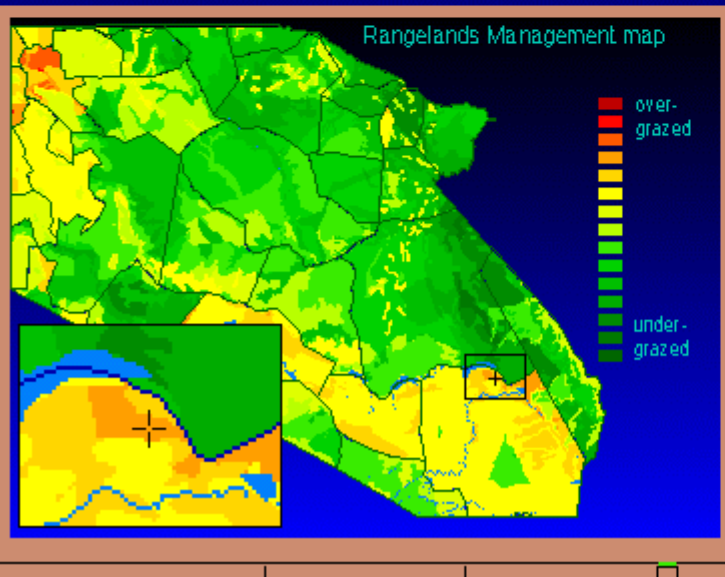
The lower part of the screen shows the schematic representation of the ISM 'Show Result' option for the Rangelands Management map.

The colour screen (left) displays the map and the monochrome screen (right) displays the tabular information on biomass statistics, livestock numbers and distance to water.

The lower left corner of the colour screen represents the enlargement of the smaller box which points out the location of the cursor. This cursor can be moved over the colour screen and per group ranch (black lines) the corresponding tabular data will be displayed on the monochrome screen.

The Rangelands Management map shows the status of the rangelands at the end of the long dry season, before the biomass production starts due to the rains of the next rainy season.

Colour Monitor



Monochrome Monitor

- Biomass statistics per group ranch
 - Sustainable Available Biomass
 - Demand of Wildlife
 - Potential Available Biomass for Livestock
 - Suitability Loss
 - Inaccessible Biomass
 - Carrying Capacity of Livestock
 - Demand of Livestock
 - Result (negative is overgrazed, positive is undergrazed)
 - Status (indicating overstocked or understocked)
- Livestock numbers
 - The present number of cattle, sheep & goat and donkeys
 - The recommended number of cattle, sheep & goat and donkeys based on sustainable grazing.
 - The required number of cattle, sheep & goat and donkeys based on the metabolic intake of the local maasal.

Competition Wildlife – Livestock

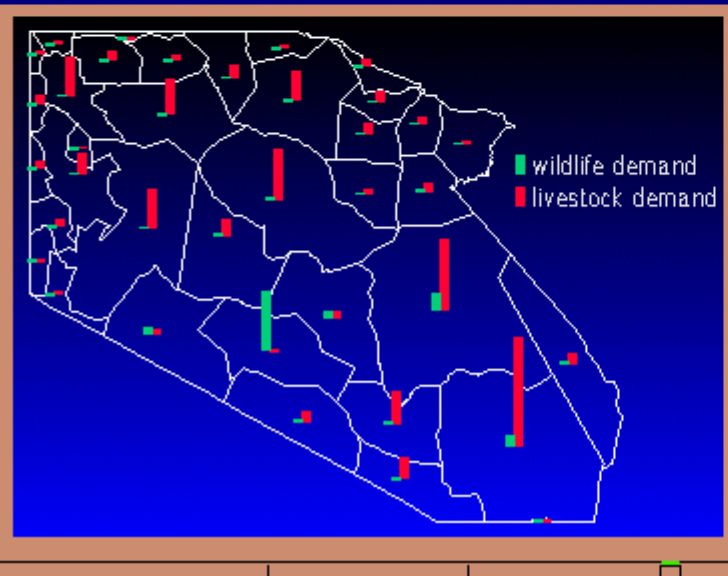
This map is indicating the ratio of forage demand between wildlife and livestock per group ranch.

This map provides information to avoid / predict conflicts between conservationists and local people when disagreement arises concerning destruction caused by wildlife (e.g., crop damage), diseases, or competition for forage.

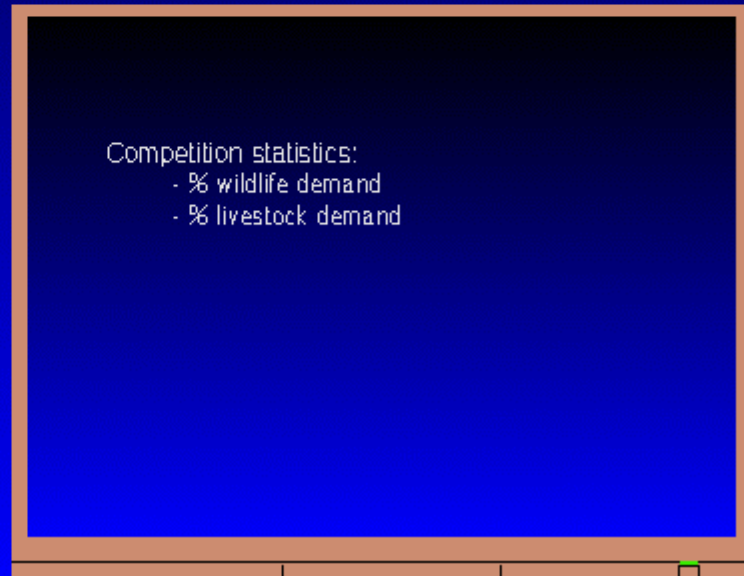
It might be helpful in estimating or predicting the amount of compensation in relation to the actual presence of wildlife per group ranch.

It should be noticed that this figure is representing the wildlife and livestock forage demand during the dry season.

Colour Monitor

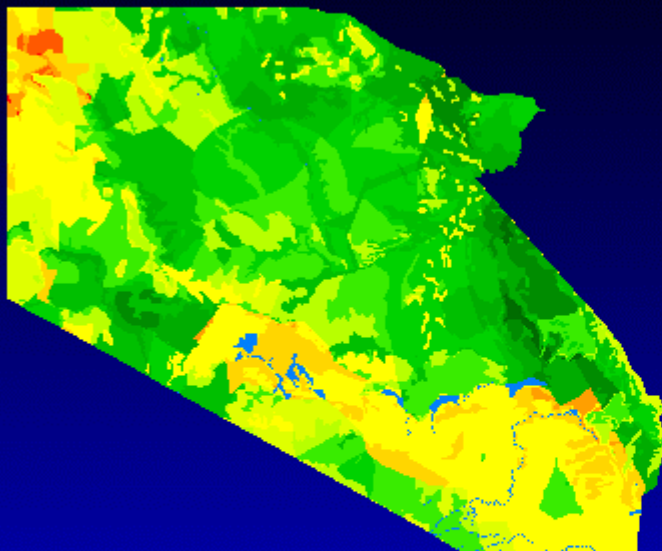


Monochrome Monitor



ISM | Interactive Spatial and temporal Modelling

Scenario 1: reduction of demand

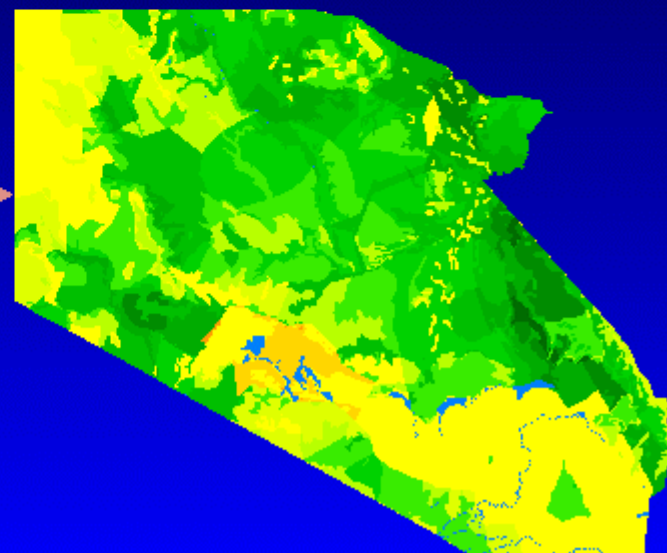


Scenario 1 is based on a reduction of the livestock number to the recommended values based on sustainable grazing.

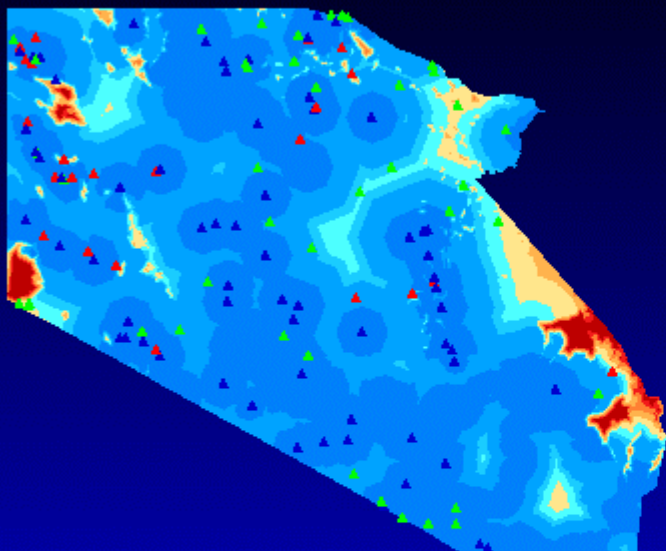
You can see, when comparing the model (left) with the result of scenario 1 (right) that the red and orange areas of overgrazing do not occur any more, except within Amboseli National Park itself.

Amboseli remains overgrazed, because the number of wildlife is too high based on the sustainable forage availability.

Recommended number
of livestock based on
sustainable grazing



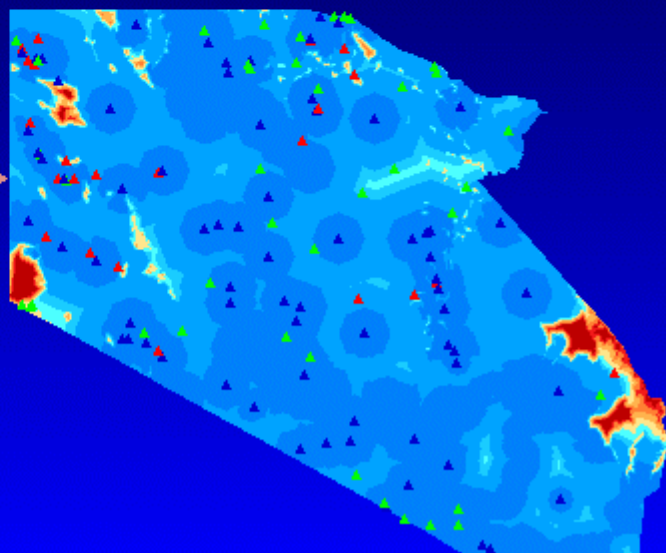
Scenario 2: increase accessibility



Scenario 2 is based on improving the accessibility to watering points.

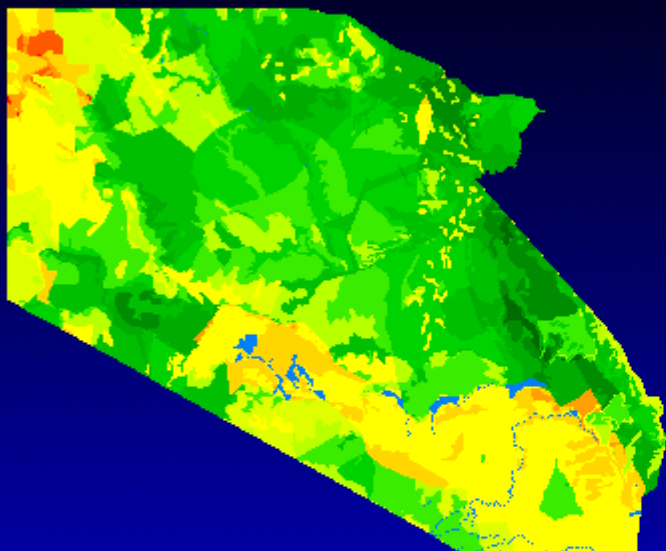
When an area with a potential forage availability is not accessible due to the limiting walking distance to water for livestock, it can be made available by an improvement of the accessibility to water in that area.

By introducing new boreholes or changing not functional boreholes into functional boreholes, the accessibility to water has been improved.



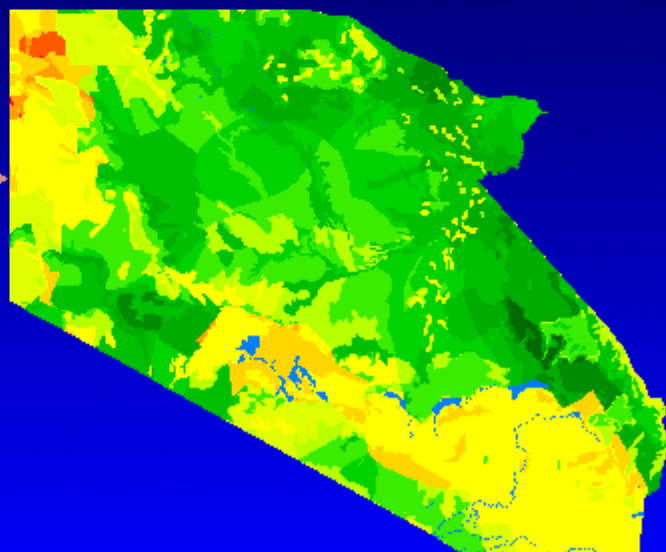
Additional boreholes
in areas less
accessible to water

Scenario 2: increase accessibility



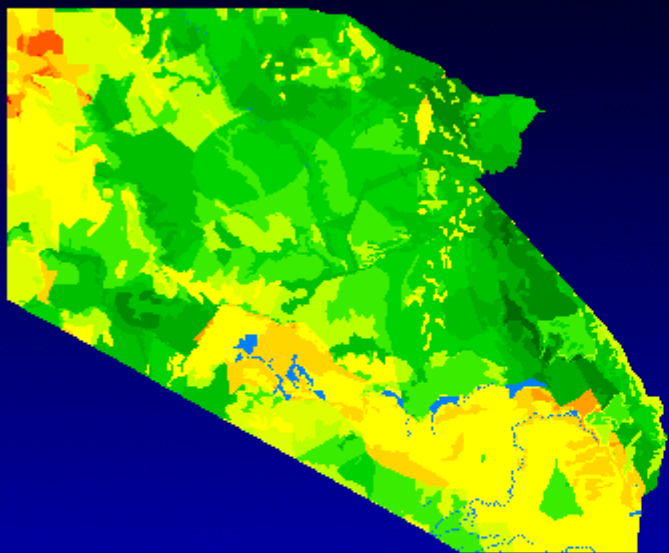
You can see that within the group ranch 'Kuku', located in the South-East of the Amboseli Biosphere Reserve, there was still some biomass available in the model situation (left).

However, the scenario shows that even when utilizing this biomass, the overgrazing will not disappear.



**Additional boreholes
in areas less
accessible to water**

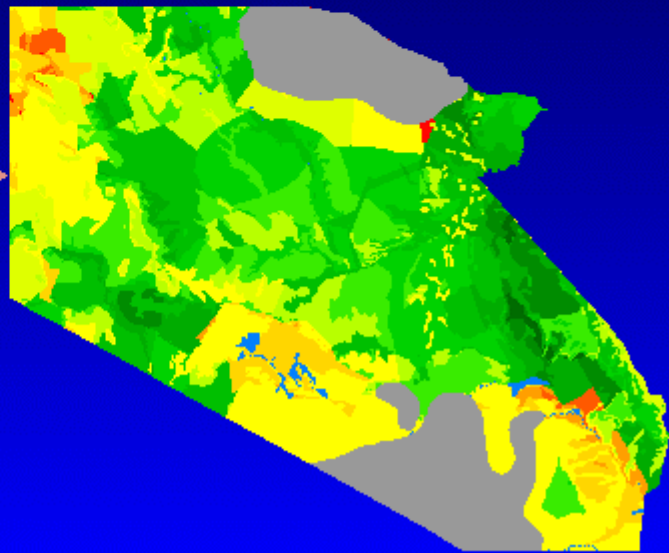
Scenario 3: reducing availability



Scenario 3 is based on the introduction of agricultural fields (■).

When agriculture is introduced, the availability will be reduced, resulting in more overgrazing in other areas, if the livestock number will not be reduced accordingly.

Introduction
of
Agriculture



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Press Esc to end the demo