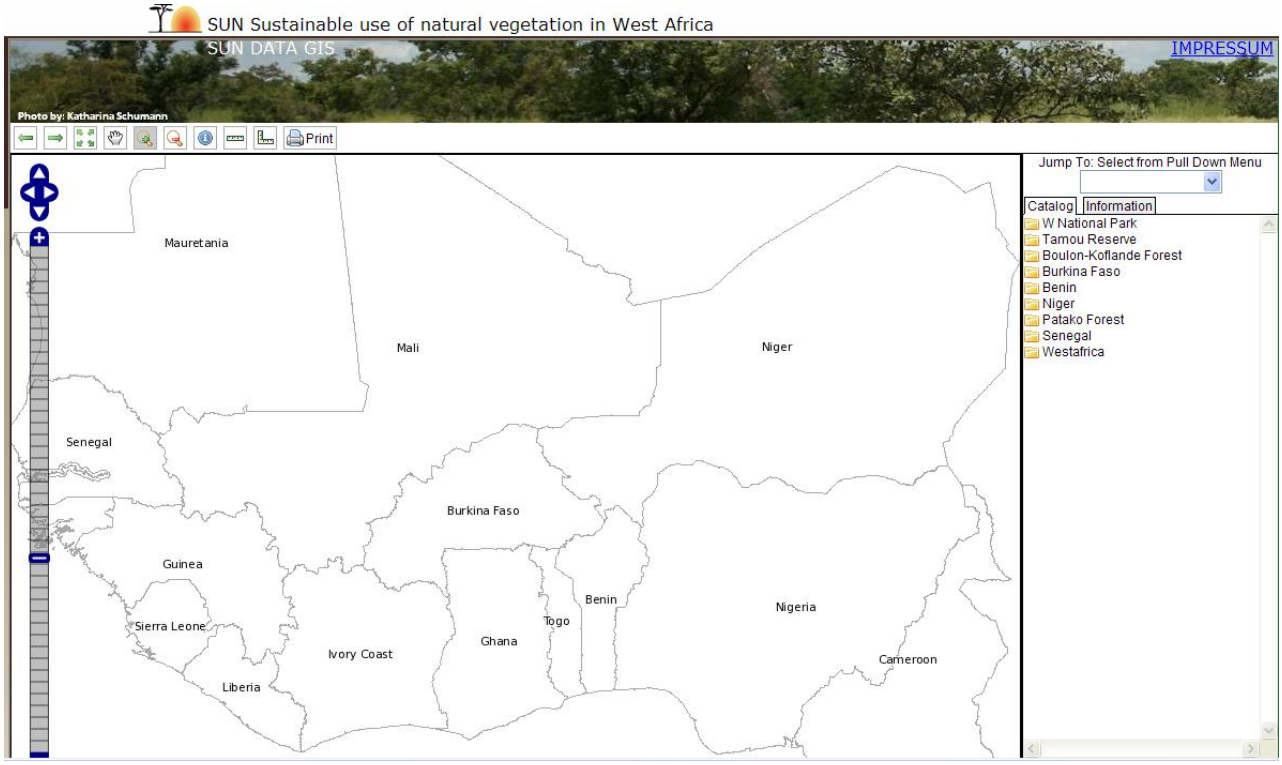
Infrastructure:	**Main paths** inside and **main roads** outside (Institut des Sciences de l'Environnement)
Fire:	**Fire Frequency** and **Fire Areas** for 2009 and 2010 (EC/JRC)

Around the Patako Forest topographic measurements were undertaken und field data about salinity, climate, invasive plants, erosion, fire frequency and human impact on the protected area were raised. Initial maps of ecosystem and of vulnerability of hotspots were produced. Further analysis to assess the vulnerability of habitats and species will be conducted by the interpretation of the Normalized Differenced Vegetation Index derived from MODIS data (WP 1, To assess habitats and species vulnerability).

D6.2 A functional GIS decision support tool, public via an internet portal

Originally, Deliverable 6.2 of the project proposal document was established the generation of a public GIS Decision Support Tool for decision makers and scientists based on project data and findings. As project time passed by, it was noticed that original SUN produced data and models would only be available after the project time as participants and PhD students had to spend a lot of time on field work, data processing and analysis. Finally, SUN members would publish their results first in the international journals before providing their data to others. It was impossible to create a Decision Support Tool without any real site data or models. Discussing the subject amongst the project partners, it was agreed to establish an Internal Project SUN Map Server that should serve for SUN participants as an information platform about available GIS and remote sensing data of the region, the participating countries and core areas. As data are downloadable from the SUN Map Server, it also functions as an interchange platform for all of the data uploaded and stored there. Still, the SUN Map Server's content is based mostly on data downloaded from Web pages of international institutions. As these data should not be mirrored, the Sun Map Server is password protected and just functions as an internal data exchange map server for the project members. As is common practice the international community, data have to be cited properly when used for further analysis and in publications. The idea is still to integrate SUN produced data once it is available and once the project participants give their permission to publish it. When the majority of the content will be composed of original SUN data, the Map Server should be accessible without constraints by the entire public and the international data would just be saved in the Geodatabases.
The SUN Map Server is running at Johann Wolfgang Goethe University of Frankfurt and can be accessed via a Link on the SUN Project Homepage (http://www.sunproject.dk/) or directly under the address http://mapserver.uni-frankfurt.de. SUN and UNDESERT participants can obtain the Login Name and Password by writing an e-mail to sunmapserver@bio.uni-frankfurt.de and requesting the access. This e-mail address can also be used for comments on the site. Updating is done regularly by the administrator of the site in Frankfurt.
The program used to design the Map Server was GeoMoose 2.2. Several functions were integrated to zoom and pan, identify features, measure line lengths and area sizes, print maps, move layers to top/bottom of stack, show the legends and download the data and metadata. The functions of the icons are explained in a HELP section.
Most of the content of the Geodatabases listed under Deliverable 6.1 form part of the Map Server. Some data are just held in the Geodatabases, as they are still being analyzed and the results have not been published yet (Footnote 1). These data are marked with **SMALL CAPITAL LETTERS** in the Geodatabases list in Chapter 6.1.
The Geodatabase content was processed and transformed into appropriate file formats for the GeoMoose 2.2 Map Server Software. Then it was transferred to a server at Frankfurt University where it is stored and can be accessed.

Initial Data Screen of SUN Map Server



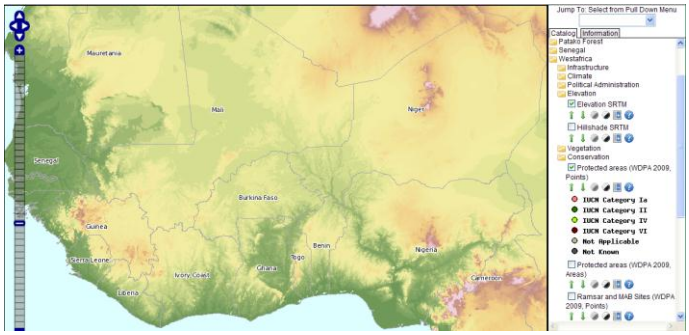
Data can be visualized, overlayed, identified, printed and downloaded. The data format is either an ESRI®Shapefile (*.shp), an ERDAS Imagine image (*.img) or a GeoTIFF format according to the data content. For each archive, a Metadata file can be downloaded with references to the data producers and data origin. Downloaded data has to be cited properly if used for analysis and in publications. It is strongly recommended to visit the data producer's original websites for further information on data property rights and correct citation.

The data can be used for indicator derivation (WP 5) and assessment of vegetation dynamics under varying degree of human impacts (WP 1). Once downloaded, it can be used for spatial analysis in Geographic Information Systems (GIS) or for map production. Most of the files possess a symbology layer as displayed in the Map Viewer.

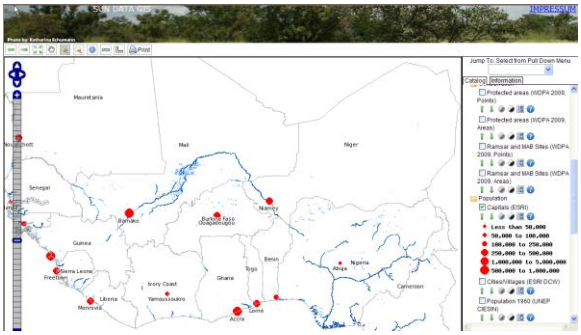
The data section for the SUN Map Server is organized the same way as the Geodatabases are. Nearly all of the data of the Geodatabases listed in chapter 6.1 are part of the Map Server. Exceptions are marked with **SMALL CAPITAL LETTERS**.

Examples for the datasets for West-Africa in the SUN Map Server

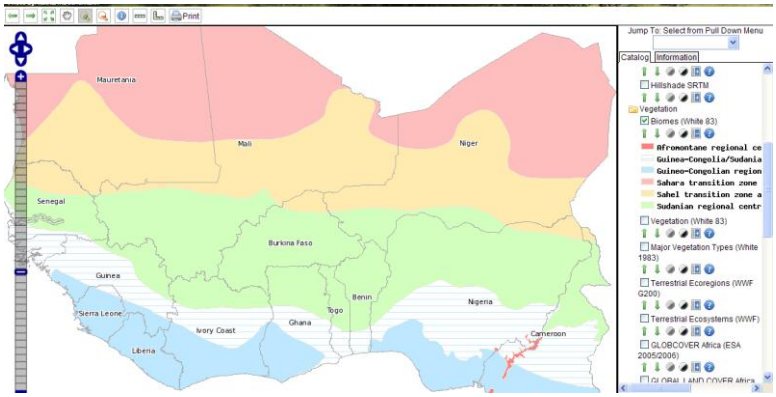
Digital Elevation Model and Country Boundaries



Capitals and Permanent Waterbodies

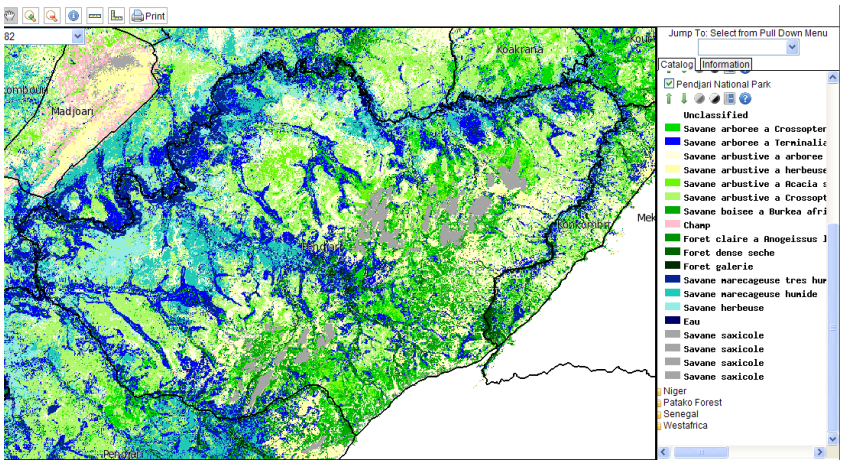


Biomes (White 1983) and Country Boundaries



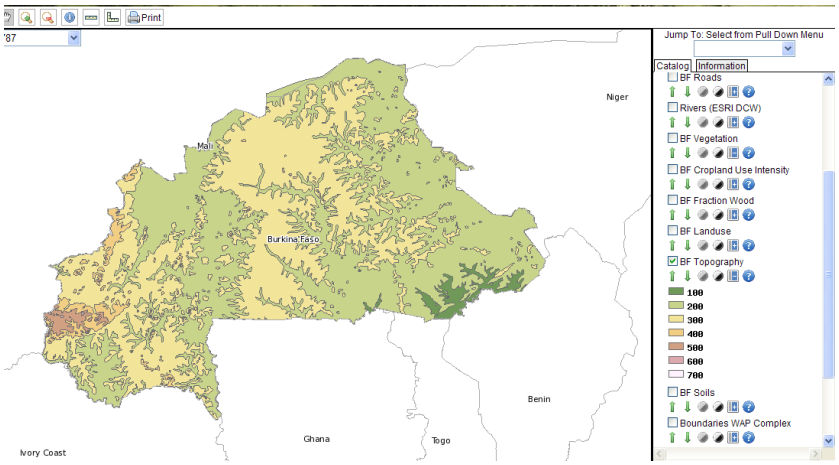
Example for the Datasets for Benin in the SUN Map Server

Vegetation Types in Pendjari National Park



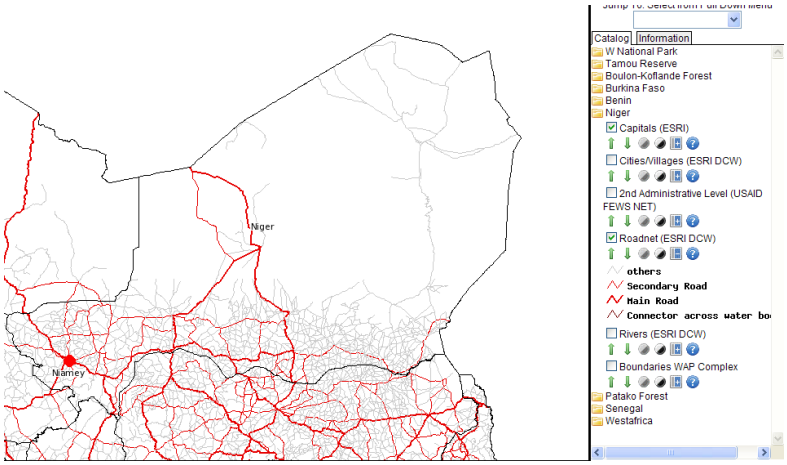
Example for the Datasets for Burkina Faso in the SUN Map Server

Elevation



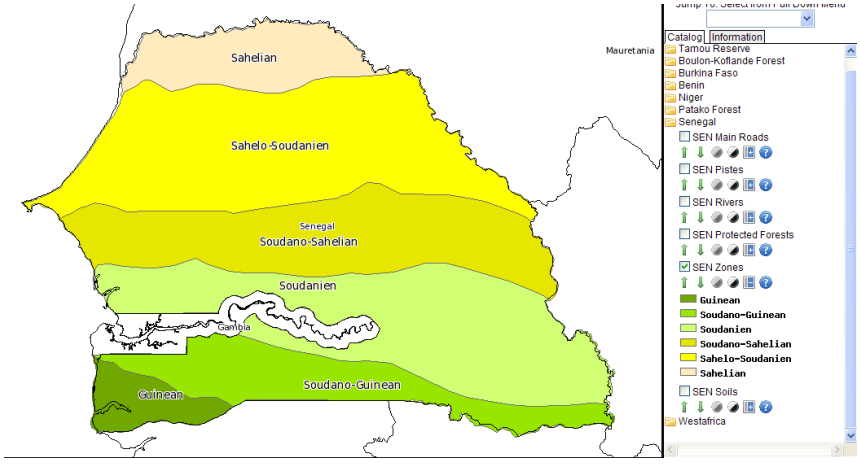
Example for the Datasets for Niger in the SUN Map Server

Roadnet



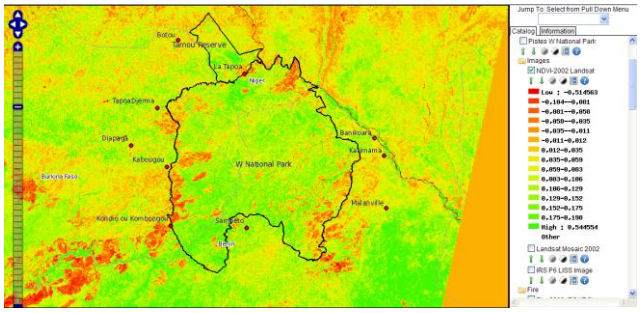
Example for the Datasets for Senegal in the SUN Map Server

Climate zones

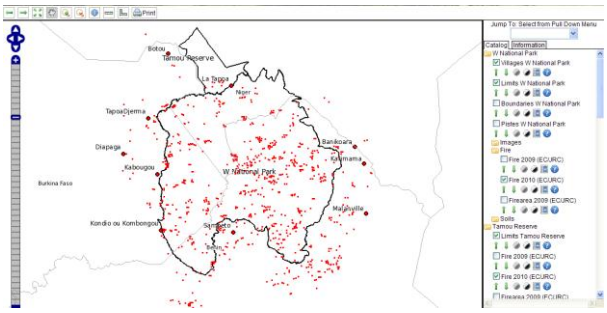


Examples for the Datasets for the three parts of W-National Park (Burkina Faso, Benin, Niger) in the SUN Map Server

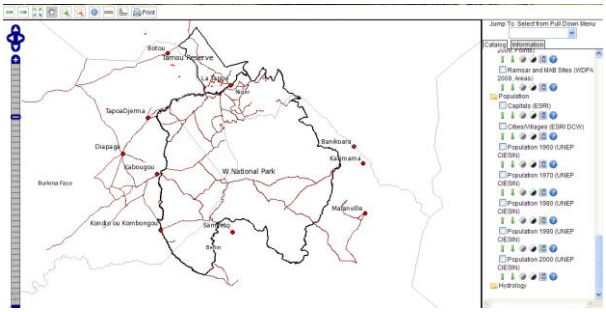
Boundaries and NDVI 2002



Boundaries and Fire Frequency (JRC)

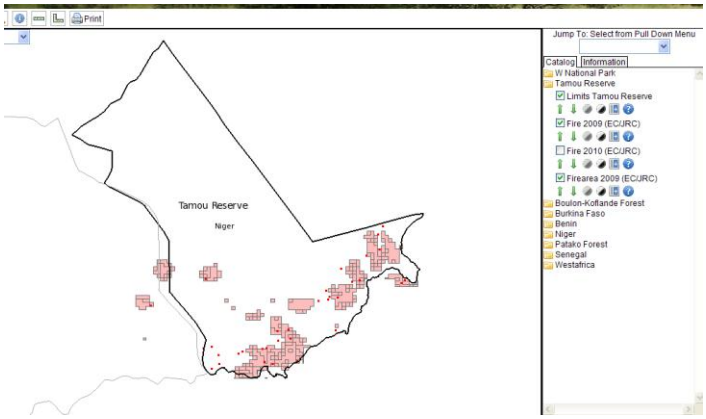


Boundaries, Routes, Villages and Country Limits



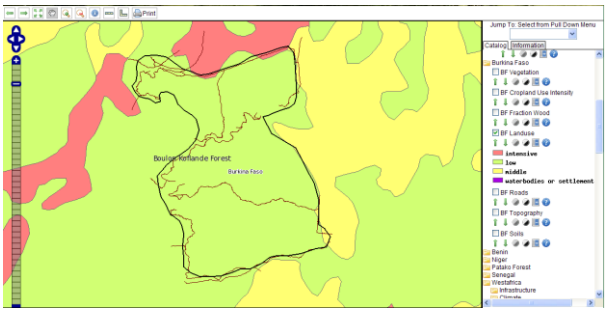
Example for the Datasets for Tamou Reserve in the SUN Map Server

Boundaries and Fire Data (JRC)

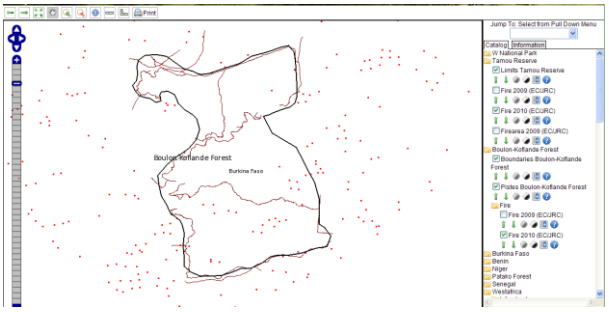


Examples for the Datasets for Boulon-Koflandé Forest in the SUN Map Server

Boundaries and Landuse

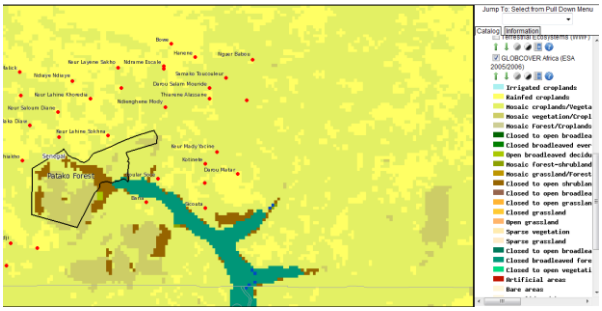


Boundaries, Paths and Fire Frequency (JRC)

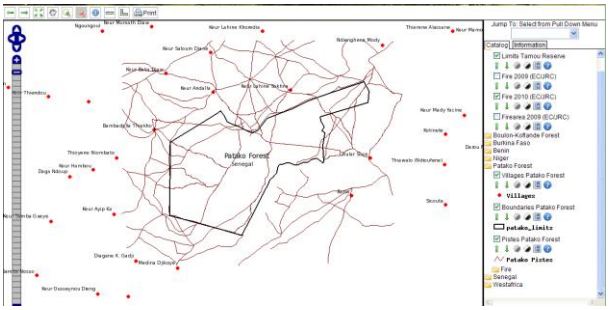


Example for the Datasets for Patako Forest in the SUN Map Server

Boundaries and Vegetation (GLOBCOVER, ESA 2005)



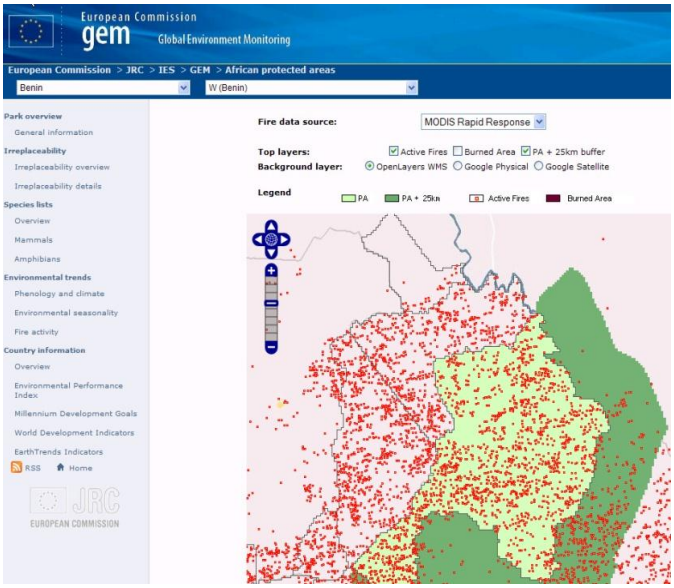
Boundaries, Paths and Villages

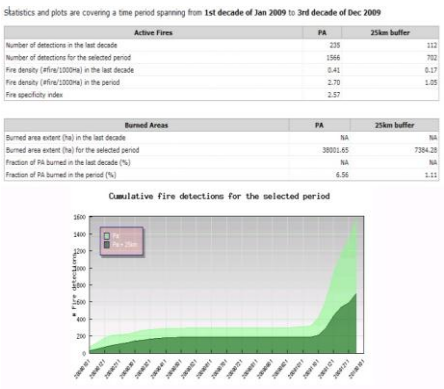


A second Map Server was set up during the SUN-project by the Joint Reserach Centre in Ispra/Italy on the Bioval Internet Page of the European Community and the JRC presenting data on fire frequency and burnt areas in West Africa (http://bioval.jrc.ec.europa.eu/PA/).
All five core sites of the SUN project (W-Benin, W-Burkina Faso, W-Niger, Tamou Reserve, Boulon-Koflandé Forest and Patako Forest) have been included in the internet portal.
During 2007, 2008 and 2009, JRC studied the fire seasonality in the five SUN core areas using thermic anomalie data derived by NASA from the MODIS sensor onboard AQUA and TERRA. Four times a day the geographic coordinates, the date and hour of active fire events and burnt areas are downloaded by an automatic routine to be processed at JRC laboratories.
The *fire seasonality* (temporal seasonality) is considered by the number of fire events per unit area over a 10-day period in the core areas and surrounding zones (in a 25 km buffer zone around each PA). The *density of fires* observed inside and outside the five protected areas is used as an indicator of their ecological peculiarity and gives information about the effectiveness of management (WP1, Analysis of indicators of sustainable use at landscape, habitat, and species scale and WP 5, Identification of landscape indicators).
On the interactive section on the Bioval Webpage, the user can define the protected area, the year and the period (complete dry season or a series of 10-days periods) of interest for fire events and burnt areas. The results are presented in a map and statistics are given for the core and surrounding zone. Shape files of the active fires and of the burnt area can be downloaded from the JRC server at http://bioval.jrc.ec.europa.eu/PA/. This web server also gives access to a series of subset of the

MODIS images, covering the region of each core sites, and to the weekly fire bulletins which were produced during the SUN project.

Distribution and statistics of active fire events for W-National Park derived by SUN Partner 9 (JRC/Italy, http://bioval.jrc.ec.europa.eu/PA/*)*





Milestones

Compiled existing spatial datasets and GIS structure at local to regional scale (month 12)

The data structure is compiled and all of the datasets are saved in eight Geodatabases according to their regional extent. Data were mainly downloaded from international Websites and processed, digitized on thematic maps and in Google Earth, collected with GPS in the field or derived from remote sensing data. Some datasets were achieved from institutions of the participating countries in SUN. The data are available to the SUN partners through the SUN Map Server (http://mapserver.uni-frankfurt.de).

Initial version of public GIS tool (month 21)

The SUN Map Server is running on a server at Johann Wolfgang Goethe University and can be accessed via a Link on the SUN Project Homepage http://www.sunproject.dk/ or under http://mapserver.uni-frankfurt.de. The login name and password has to be obtained before at: sunmapserver@bio.uni-frankfurt.de.

GIS tool established (month 36).

The SUN Map Server is running on a server at Johann Wolfgang Goethe University and can be accessed via a Link on the SUN Project Homepage http://www.sunproject.dk/ or under http://mapserver.uni-frankfurt.de. The login name and password have to be obtained before at: sunmapserver@bio.uni-frankfurt.de.

All of the data can be downloaded with their Metadata and symbology files and can be used for further analysis or map production. A GIS Decision Support Tool could not be established due to lack of specific SUN produced data and models.

Expected results

The SUN Map Server was established in order to serve as a data interchange platform for the SUN project members. Still, the amount of SUN produced data is very small, but as more and more PhD students are finishing their doctoral thesis, there should be more site specific data available soon that could be integrated in the Map Server. SUN, and now also UNDESERT participants, should enter the Map Server site, check for the availability of information for their scientific studies at different scales, download the data and use it for spatial analysis and map production.

WP7 Local management actions

Coordinator Partner 3
Participants: P2, P3 Dakar (44), P4 Frankfurt (58), P5 Senckenberg (5), P6 Ouagadougou (44), P8 Cotonou (44)

WP objectives:
The overall objective of this work package is to set clear objectives and carry out local participatory management plans.

The specific objectives are:
Participatory preparation of a management plan for each core area;
Accomplishment of management plan with local responsibility;
Evaluation of management strategies and extraction of best practices for dissemination.

Deliverables

D7.1 Management plans for core areas established in a participatory manner.

Two participatory management plans exist in the core areas of the Boulon Koflande and Patako forests. For Boulon Koflande, a management plan already was in place at the time of the project start. For the Patako forest, the management plan has been elaborated during the implementation of the project. A participatory approach has been adopted, and many studies have been done by different partners. This management plan is intended to be an example/a model that can be used for elaboration of management plans in other areas, therefore, a large work load has been put into the Patako management plan.

Methodology of the management plan elaboration

A participatory approach based on strong implication of local stakeholders has been achieved throughout the process, and the following steps were realized during the elaboration of the management plan of the Patako forest.

- Literature review on the status of the arts on management plans
- Site visits at institutions for information collection
- Collection of experience learned from other countries (Burkina Faso, Benin)
- Field data collection based on team work of two groups: biophysical and socio-economic. During field data collection, various activities were done:
    - Field mission for first contact and presentation of the project (local population and state services);
    - Signature of an agreement of understanding between P3 and the forest department;
    - Participation of local communities in key information collection to feed the management plan;
    - Joint field visit with local populations;
    - Several focus group meetings with local stakeholders;
    - Visit by key institutions involved in natural resources management in the Patako forest;

- Visit by the team to local leaders (cultural, religious, political and administrative) to inform and share ideas about main direction to be taken for an adapted management plan;
- Regular teamwork (at least once a month) for adjustment of the management plan using incoming information and updates. Information exchange between the biophysical and socio-economic groups and synthesis of existing information;
- Interview of national resources persons on resources management;
- Internal writing workshop for the first draft of the management plan and gap identification requiring subsequent investigations;
- Complementary study of biophysical information.

During this process, zoning of the core was one of the key activities which required data integration using topography, vegetation maps, and land use information (see figure 7.1 and zoning report below). The zoning requests a strong implication of local stakeholders who are in charge the validation of the core area zoning, a participatory identification of characteristics and constraints of main zones, an identification of activities and actions to be taken for a sustainable use of forest resources and also an identification of complementary activities to the conservation activities and after that set up local management committees for the implementation of the management plan activities.

Figure 7.1: Patako forest zoning

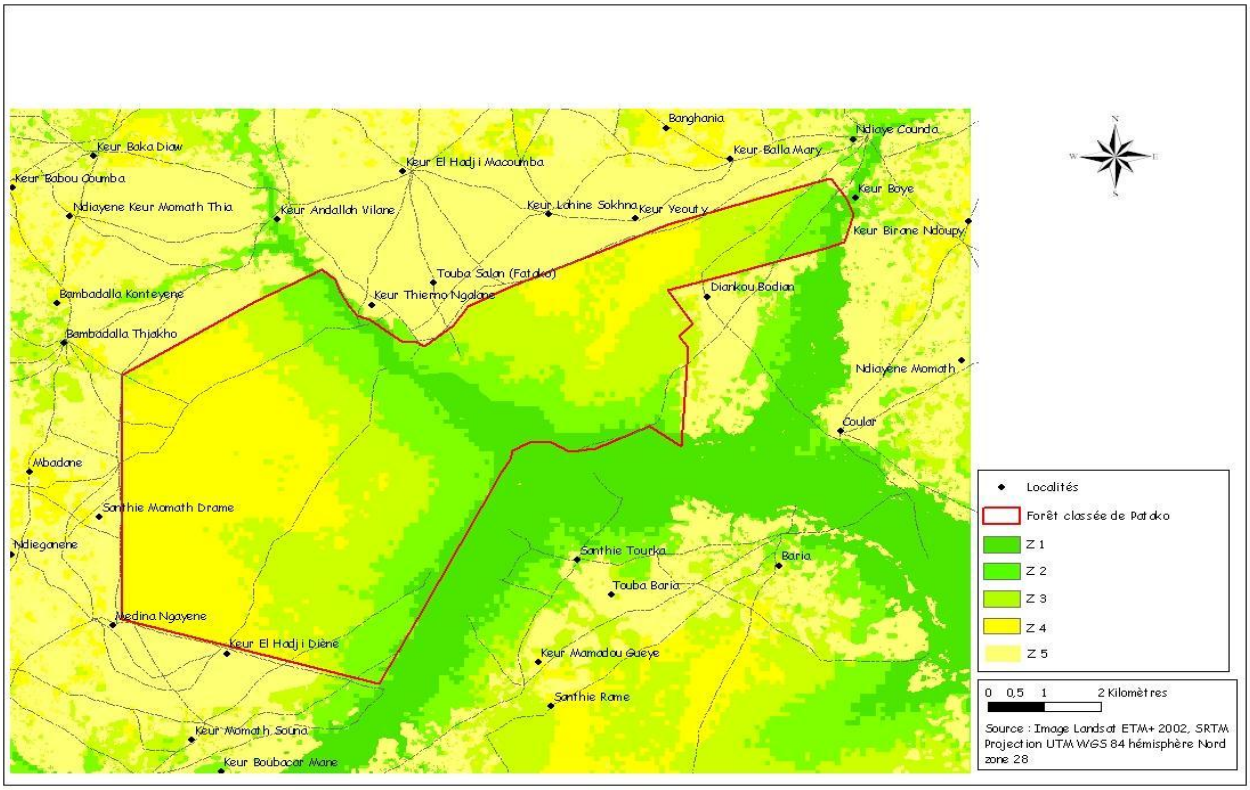


Table 7.1: Zoning report

Legend	Landscape	Floristic composition	Topography	Soils type	Activities/use	Constraints	Planning proposition
Zone 1	Gallery forest, mangrove	*Anthocleista procera*, *Ficus congensis*, *Calamus* sp., *Saba senegalensis*, *Combretum tomentosum* , *Phoenix reclinata*, *Elaeis guineensis*, *Nauclea latifolia*, *Morinda geminata*, *Alchornea cordifolia*, *Typha* sp., *Ficus sur*, *Khaya senegalensis* et *Kigelia africana*, *Paulinnia pinnata Khaya senegalensis*, *Avicennia* sp…	Alluvial valley	Hydromorphic soil, gleysols	Fishing, wood, gardening, rice growing, apiculture palm wine, fruits, medicine, beekeeping	Salinisation Sedimentation Aquatic invasive plants (*Typha domengensis*)	Area of conservation of the biodiversity, Area of collect of straw and limited exploitation of medicinal plants
Zone 2	Woodlans / savanna	*Combretum glutinosum*, *Combretum nigricans*, *Cordyla pinnata*, *Daniellia oliveri*, *Terminalia macroptera*, *Pterocarpus erinaceus*, *Lannea acida*, *Khaya senegalensis*, *detarium microcarpum*…	Downslope	Hydromorphic soil, tropical ferruginous soils	Gardening, arboriculture, wood, fruits, medicine, beekeeping	Bush fires, Uncontrolled and over exploitation	Controlled exploitation area: wood energy, fruits, straw
Zone 3	Deciduous closed / open shrublands	*Combretum glutinosum*, *Combretum nigricans*, *Cordyla pinnata*, *Daniellia oliveri*, *Terminalia macroptera*, *Pterocarpus erinaceus*, *Lannea acida*…	Slope	Tropical ferruginous soils	Wood, grazing, fruits, medicine, beekeeping	Bush fires, Uncontrolled and over exploitation	Exploitation area: wood energy, grazing
Zone 4	Deciduous closed / open shrublands	*Combretum glutinosum*, *Combretum nigricans*, *Cordyla pinnata*, *Daniellia oliveri*, *Terminalia macroptera*, *Pterocarpus erinaceus*, *Lannea acida*…	Plateau	Tropical ferruginous soils	Wood, grazing, fruits, medicine, beekeeping	Bush fires, Uncontrolled and over exploitation	Exploitation area: wood energy grazing
Zone 5	Agriculture area	*Cordyla pinnata*, *Parkia biglobosa* …	Plateau	Tropical ferruginous soils	Agriculture (millet, peanuts…)	Erosion Loss of soil fertility Parasitic plant (*Striga hermonthica*)	Agriculture area, bois de villages, Community conservation area

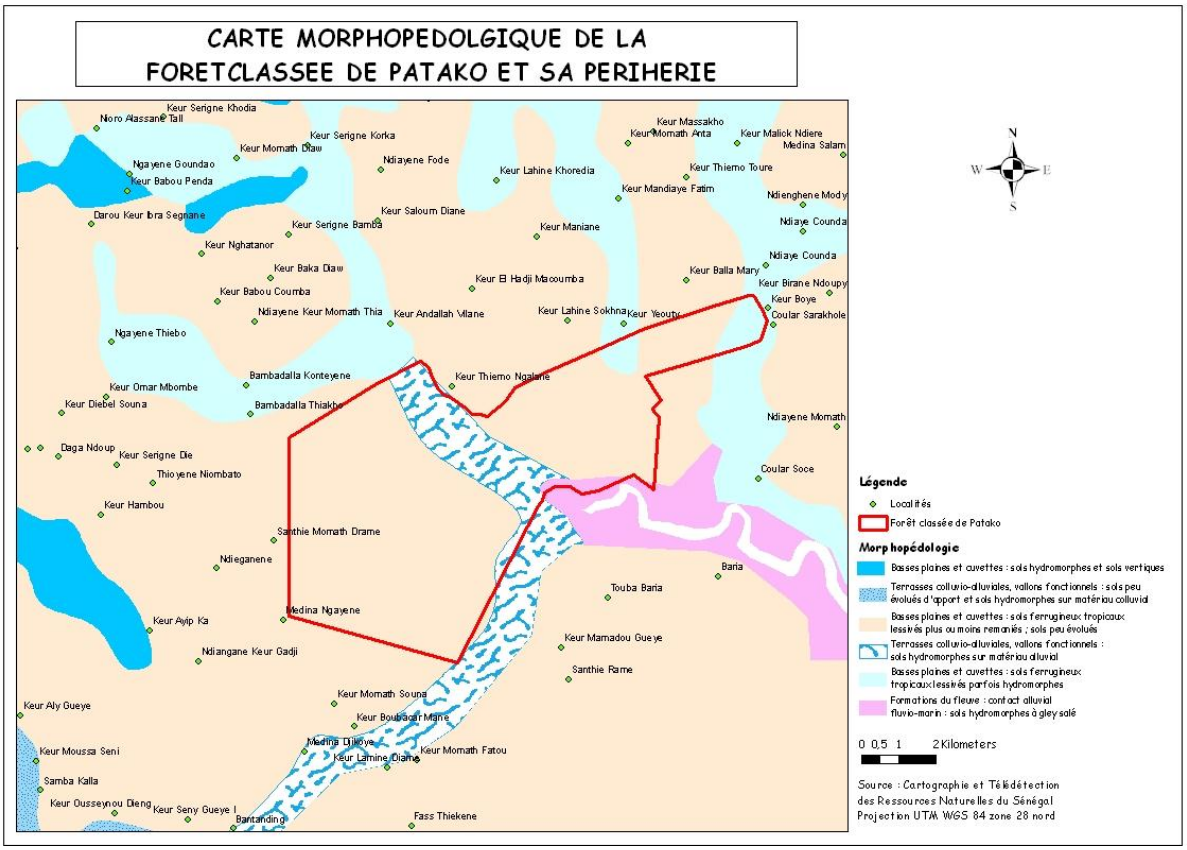
Photo 1. Meeting for validation of the zoning: SUN project student explaining the zoning

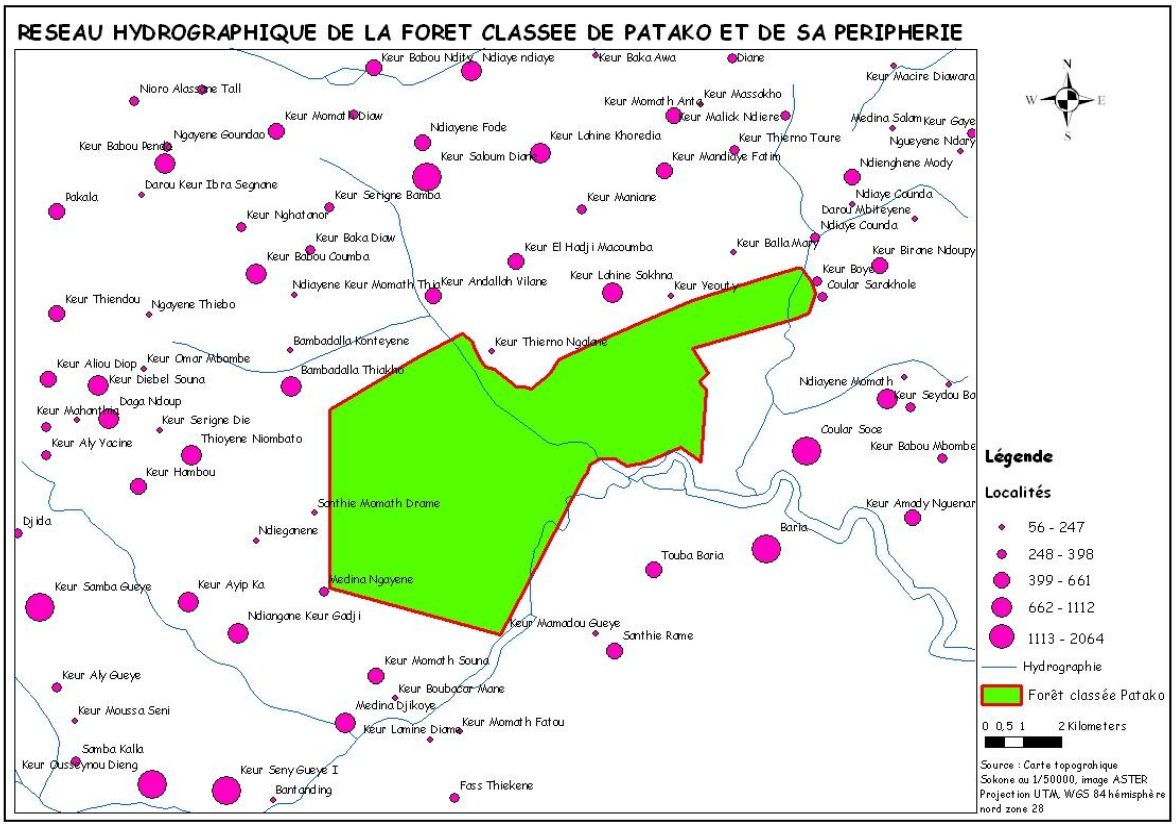
Photo 2. Meeting for validation of the zoning: Representative of local communities giving his point of view in the zoning

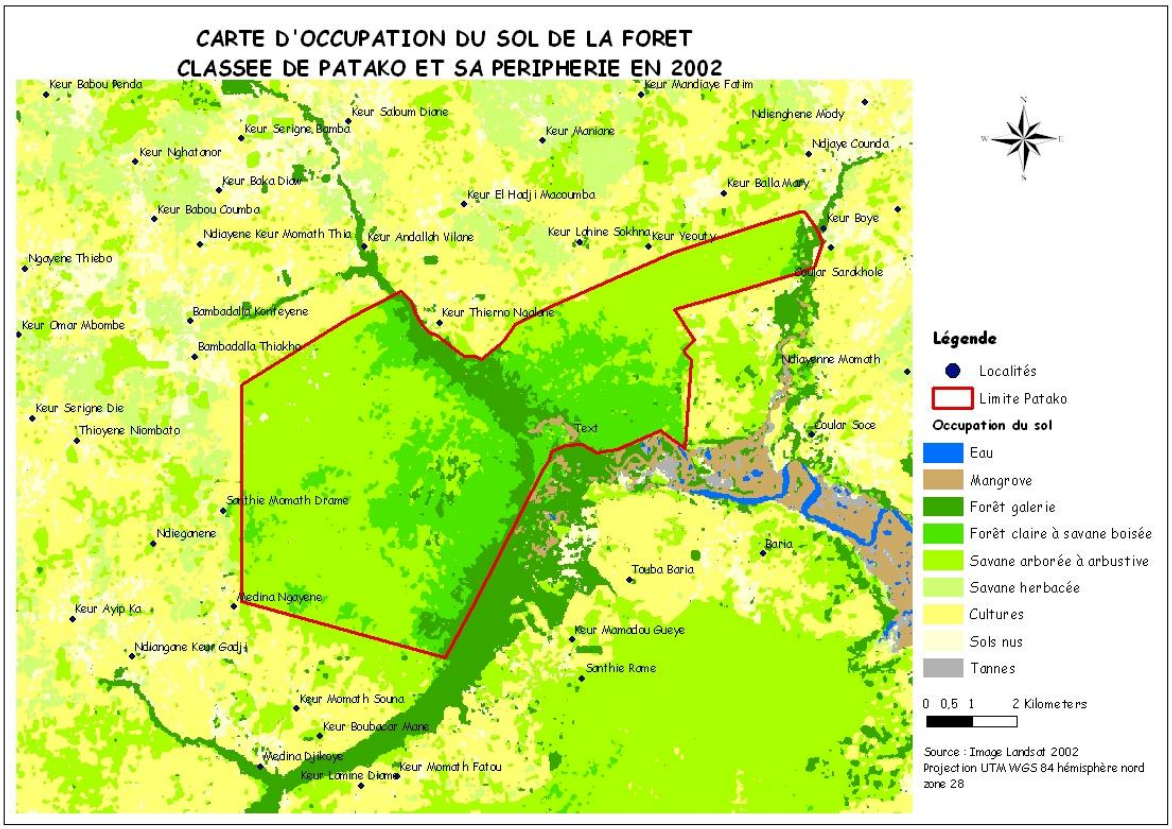
Scientific studies for the management plan

Biophysical and socio-economical studies have been done by students of the project during the implementation of the project; these data have been collated using a participatory approach based on strong implication of local stakeholders. First, an authorization was obtained by signature of an agreement of understanding between the local coordinator of SUN project and the forest department which is responsible for forest management. Also, all data have been collated in close collaboration with local the population.

The Patako forest is located in the Foundiougne Department and the Fatick region. This forest is located in the sudanian zone, was classified in 1934 and covers 5638 hectares. Topography is dominated by small highlands and cuvettes, but the forest is crossed by two major valleys. One of the valleys has a steady flow with upstream freshwater and brackish saline water downstream. The tropical ferruginous soils more or less represent 60% of reworked soils in this area. The vegetation is dominated by shrubs and medium-sized trees on the highlands and the most important woody species are *Pterocarpus erinaceus, Bombax costatum, Lannea acida, Cordyla pinnata, Acacia macrostachya, Combretum glutinosum and Ozoro insignis.* Herbaceous flora is dominated by *Andropogon gayanus, Pennicetum pedicellatum Spermacoce chaetocephala.* In the valleys, the vegetation is mainly composed of large trees with a high density compared to the highland. In the valley, the most frequently encountered species are *Elaeis guineensis, Ficus congensis, Khaya senegalensis, Erythrophleum suaveolens, Afzelia africana, pinnata Paulinia, Calamus deeratus* and many lianas. In the confluence of the two main valleys, the vegetation is mainly formed by mangrove species such as *Avicennia africana*. Vegetation damage is visible due to tree felling and bush fires. Wildlife is particularly well represented. Hyena (*Crocuta crocuta*), warthog (*Phacocherus aethiopicus*), hare (*Lepus crawshayi*), green monkey (*Cercopithecus aethiops*), patas (*Erythrocebus patas*), red colobus (*Colobus badius*), the duiker, the red-flanked duiker, the Nile crocodile (*Crocodylus niloticus*), python (*Python sebae*), the puff adder (*Bitis Lachesis*) and diverse species of fish like Tilapia and Catfish.







Information concerning socio-economic aspects has been collected. The results show that the two administrative entities (Keur Saloum Diane and Keur Samba Gueye), which are adjacent to the forest, have a population of 48,133 inhabitants. The population density average is about 93

inhabitants per km2. The human environment is very diverse, favored by the search for new lands. Demographic trends since 1976 reflect a young population, low education and that the population is doubling every 15 years. The main activities are agriculture and livestock, which currently face major difficulties. The high density of population poverty (46.3%) constitutes a big constraint to the conservation of the Patako forest.

Forest products have been used by local populations. These products are primarily wood (32.30%), leaves (23.60%), bark (16.60%) fruit (15.80%), and roots (2.90 %). In each product category, people target a certain number of species. Thus, *Combretum glutinosum* and *Cordyla pinnata* are the species most used for wood energy and timber, respectively. The species most used for non-timber products are *Combretum micranthum* (leaf), *Daniellia oliveri*, *Pterocarpus erinaceus* (bark) and *Detarium senegalense* (fruit). Other products are the lifeblood of *Eleais guineensis* and resin of *Sterculia setigera*. Within the 73 woody species listed, the preferences of local populations have focused on 34 species. Among men, the ability to draw timber service was the most important criterion in determining the choice of species, followed by potential uses in herbal medicine in animal feed and human consumption. In women, preferences are more influenced by supply options in wild fruits and firewood. The possibility of making remedies against the improprieties of motherhood, childhood diseases, malaria and hypertension was also decisive in the choice of species among women. *Parkia biglobosa* and *Cordyla pinnata* are two strong preferences in the southern part of the Saloum, despite the significant quantitative regression of the population of these species.

Figure 7.2: Population evolution of the two rural localities

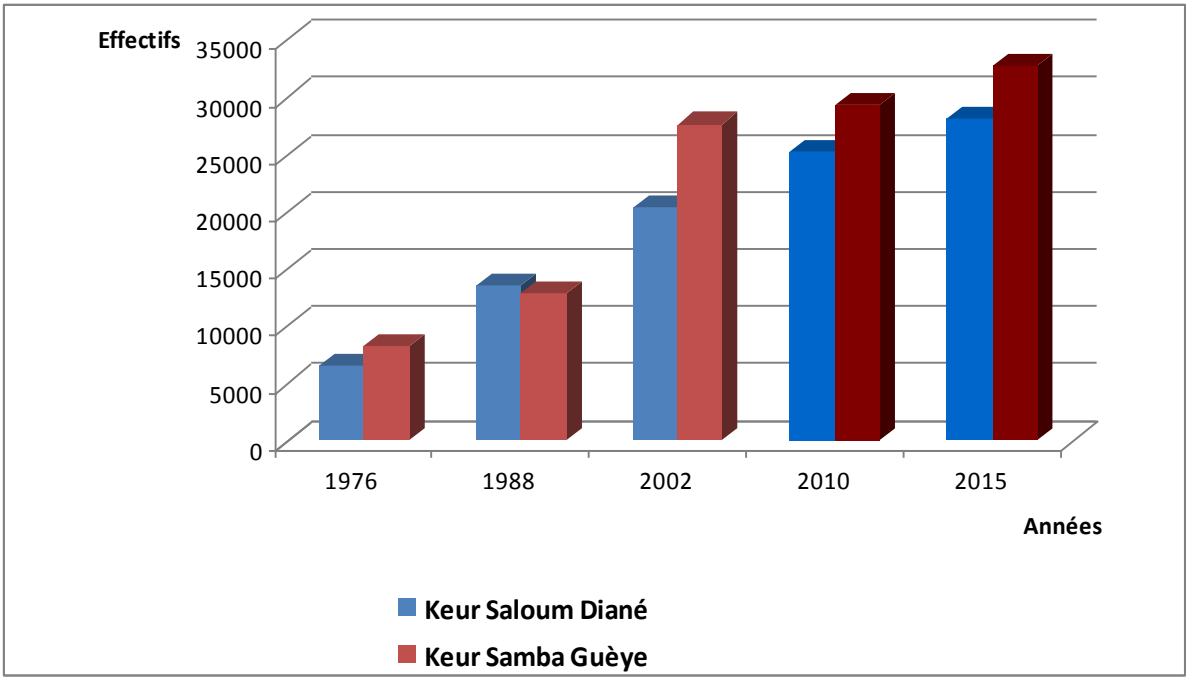


Table 7.2: Repartition of the population in the villages (KSD)

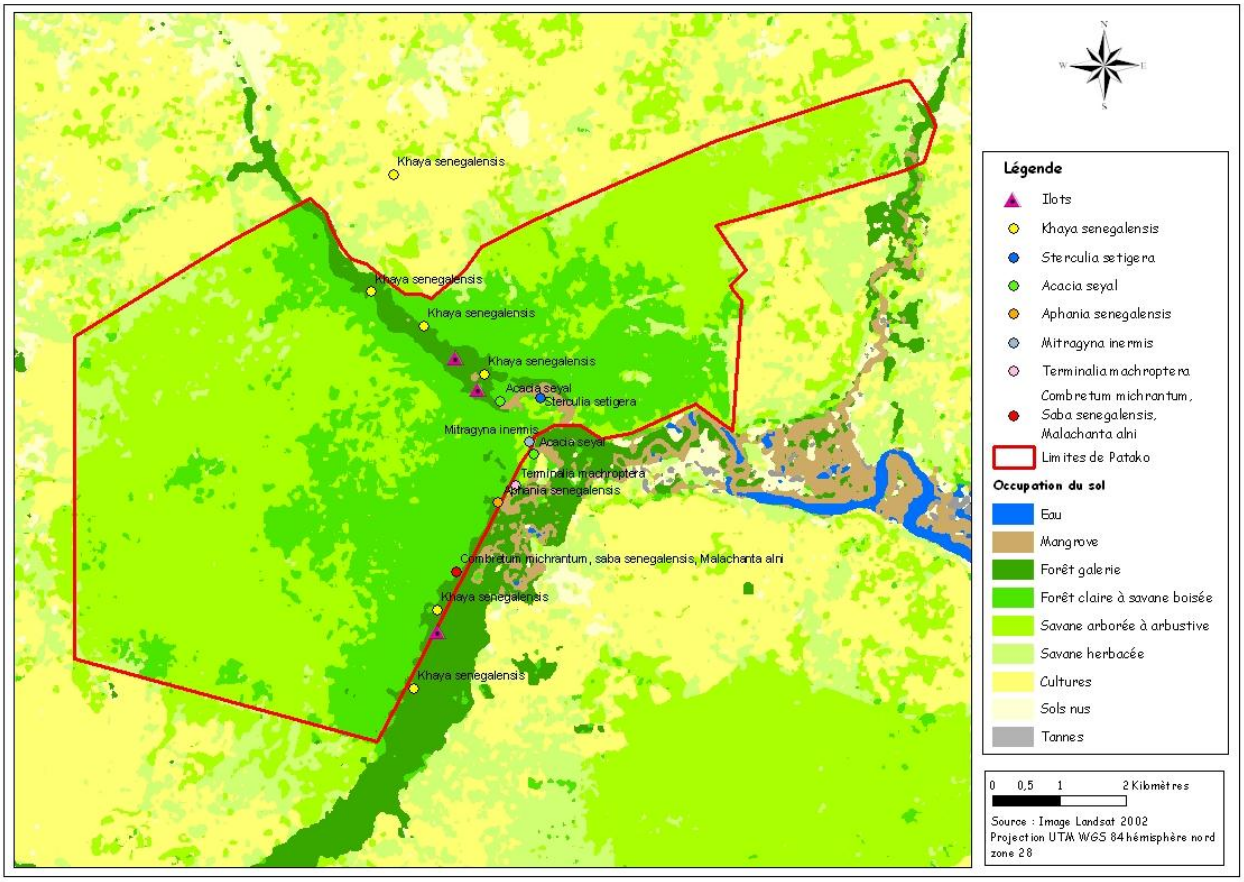
Population density	**Number of villages**	**% village**	**Population**	**% population**
Less than 100hbts	04	8,5	228	1,2
To 100 at 500	27	57,4	7943	38,8
To 500 at 1000	13	27,7	8373	40,9
More than 1000hbts	03	6,4	3909	19,1
TOTAL	47	100	20453	100

A part studies done by students of the project, complementary studies concerning flora and vegetation types of Patako forest valley and also herbaceous flora of the forest. This study shows that species diversity is high in the Patako forest valley, with about 316 plant species, including 36 cultivated species. The most important families are *Fabaceae* (21 species), *Poaceae* (21 species), *Caesalpiniaceae* (19 species), *Malvaceae* (17 species), *Rubiaceae* (14 species), *Combretaceae* (13 species), *Moraceae* (12 species) of *Mimosaceae* (11 species), *Convolvulaceae* (10 species), *Asteraceae* (nine species), *Euphorbiaceae* (9 species), *Anacardiaceae* (8 species), *Cyperaceae* (8 species), *Tiliaceae* (7 species), the *Lamiaceae* (7 species), *Solanaceae* (6 species), *Apocynaceae* (6 species), *Cucurbutaceae* (6 species), *Polygonaceae* (6 species) and *Capparidaceae*, *Asclepiadaceae*, *Arecaceae*, each with 5 species.

The main vegetation types are forest galleries, woodlands, thickets and savannah. Natural regeneration is most important at the Valley Keur Andale. It is more abundant for *Paullinia pinnata, Saba senegalensis, Spondias mombin, Calamus deeratus, Phoenix reclinata and Syzygium guineense*. Plant species used for timber and/or fruits are *Eucalyptus camadulensis, Pterocarpus erinaceus, Antocleista procera, Elaeis guieensis, Avicennia germinans, Raphia sp., Phoenix reclinata, Mangifera indica, Anacardium occidentale* and *Saba senegalensis.* The forms of exploitation that are most harmful are cuts in adult subjects, gathering wild fruits before they mature, and stripping repetitive *Daniellia oliveri, bleeding Phoenix reclinata* and use of fire during the honey harvest bush. The main species of gallery forest and savanna have been mapped as well as the status of species. Despite the diversity of this particular ecosystem, many species have been exploited. The following map shows the use of plant resources in relation to their distribution along the valley (figure 7.3). There is a different type of exploitation, but wood exploitation significantly impacts species such as *Eucalyptus camadulensis, Pterocarpus erinaceus, Antocleista procera, Elaeis guieensis, Avicennia germinans, Raphia sp., Phoenix reclinata* and *Anacardium occidentale.*

This study also recommends adopting a conservation strategy of biodiversity in the valleys in order to improve forest resources management in Patako. The proposed strategy concerns a series of conservation measures in the valleys. It mainly concerns the management of vegetation, wildlife, soil and also training and education of local stakeholders.

Figure 7.3.: Vegetation types and species distribution



A complementary study concerning herbaceous flora of the Patako forest has been also done. 205 species were collected, among them 158 species were identified. The non identification of the remaining 47 species is due to non fertility of samples and also a problem of conservation. The identified species are recorded in the following table.

Table 7.3: Taxonomic repartition of species

	Familles		**Genus**		**Species**	
	Number	**%**	**Number**		**Number**	**%**
Dicots	**29**	**76,32**	**62**	**Dicots**	**29**	**76,32**
Monocots	**8**	**21,05**	**35**	**Monocots**	**8**	**21,05**
Cryptogams	**1**	**2,63**	**1**	**Cryptogams**	**1**	**2,63**
Total	38	100	98	Total	38	100

The Patako forest flora is characterized by a dominance of Terophytes (T) with 124 species (78.48%) followed by hemicryptophytes with 14 species (8.86%) and geophytes with 13 species (8.23%).

Table 7.4.: Proportion of species types

Biological Types	Species Number	Percentage
Terophytes (T)	124	78,48
Hemicryptophytes (H)	14	8,86
Geophytes (G)	13	8,23
Others	3	1,90
Chamephytes (C)	2	1,27
Nanophanerophytes (P)	2	1,27
TOTAL	158	100

In the floristic list, 47 species, which represent 28.5% of the species, are used for fodder with a dominance of Terophytes (37 species) followed by geophytes and hemicryptophytes, each having 4 species (8.89%). The geographical distribution shows that 73, 33% of the species are represented in 3 regions (see table 7.3)

D7.2 Active management activities

Many management activities have been done in the core area of Park W in Burkina Faso and in Benin. In Burkina Faso, recommendations have been developed for harvesting of baobab trees. Based on the results of WP1 and WP5, moderate pruning practices (leave harvesting) of medium and large trees can be recommended, as fruit production is not severely affected by these activities and/or even enhanced by low pruning. In the core area of Park W in Benin, monitoring plots were established and monitored twice a year beginning in 2008. Long-term, but also medium- and short-term data from regularly surveyed permanent plots, provide a basis for the development of management practices and also the development of matrix population models. The modelling approach provides a powerful tool to describe the faith of individuals within a population in a plant community over time. Population models will be used to calculate mortality rates, transition and survival probabilities for selected highly valued species. By modelling trends in population development, management tools will be developed and adjusted.

Tree planting activities have been carried out, but are described under WP8.

Constraints
A strong constraint was the delay in the fund transfers (one year), which caused delays in the realization of project activities, particularly the last missions for the finalization of the management plan in the Patako area, which must be participative with regular field missions. Therefore, some of the plans had to be changed. For the Patako forest, the management plan exists and the implementation of management activities will be done during the EU supported project, UNDESERT, which is presently running. UNDESERT constitutes an opportunity for the continuation of the SUN project activities, especially management activities and their evaluation.

D7.3 Evaluation of management activities and recommendations for best strategies

Evaluation of management activities and recommendations for best strategies depend on the management plan implementation which, as described above, has been postponed. This evaluation consists of an appreciation of management activities by identifying success and failure factors of the management activities which have not been achieved due to the delays of the management plan

implementation. As the management activities, the evaluation will be done as part of the UNDESERT project implementation.

WP8 Restoration action

Prof. Adjima Thiombiano, Partner 6

Participants: P6 Ouagadougou (44), P7 Bobo (44), P 8Cotonou (44), P 10 Niamey (48)

Soil degradation is a major problem in Sahelian countries. Combined effects of low fertility of soils, bad management of ecosystems and very severe climatic conditions lead to sealed and encrusted bare soils, locally called "zippélé" in the mossi region in Burkina Faso. This impedes agricultural and pastoral activities. Soil rehabilitation becomes critical when finding alternatives that will help to restore the productivity of these degraded ecosystems. We hypothesize that soil and water conservation practices improve regeneration and create good conditions for plant survival and growth.

WP objectives:
To develop and improve restoration methods for vegetation rehabilitation in degraded ecosystems by using local species of high use value for concrete low-budget actions. The main objectives are on the one hand to test whether the chosen species are able to grow under hard conditions and on the other hand to restore the degraded sites by using different treatments of soil.

The specific objectives are:
- To identify and test appropriate local woody species of high use value for restoration of degraded systems with regard to different habitats and vegetation zones.
- To develop low-budget techniques and to test combinations with other restoration techniques.
- To evaluate the acceptance by local communities for planting native species.
- To define the best strategies (individual/private or local community plantation) for plantation and sustainable long-term management of planted trees.

Deliverables

Restoration activities were carried by 4 teams on different ecological sites of Benin, Burkina Faso and Niger. A total of 10 ha were restored using low-cost budget (traditional) techniques and deep ploughing (modern technique). In total, 2500 saplings of value species were planted by all the teams.

D8.1 List of appropriate species for vegetation restoration in different habitats and vegetation zones.

Experimental plots have been established in different ecological zones and the appropriate species list has been compiled considering ecological conditions and through a participatory approach with local populations.

Work performed by University of Bobo

Restoration experiments were conducted in an ecosystemic approach by applying soil conservation techniques to improve spontaneous vegetation diversity and cover for soil fertility improvement. Plantations were done in the soudanian zone (Bobo-Dioulasso) using local high value woody species: 40 saplings of *Adansonia digitata,* 75 saplings of *Pterocarpus erinaceus*, 307 saplings of *Faidherbia albida,* 188 saplings of *Afzelia africana* and 159 saplings of *Tamarindus indica*. These species were chosen in a participatory approach with local populations.

After 3 years of experimentation, results show that appropriate species to grow on degraded soils are *Pterocarpus erinaceus, Afzelia africana, Adansonia digitata*. The total area of plantation is about 3 ha.

Work to performed by University of Cotonou

The development of appropriate restoration strategies for the rehabilitation of degraded ecosystems of W National Park and its land use area requires:
(i) identification of the determining factors of erosion and soil degradation according to local people's perception. (ii) inventory of spared species by peasants in their farm and their socio-economic importance (iii) identification and testing of appropriate plant species for restoration in degraded ecosystems. Erosion and soil degradation are major threats for the sustainable use of land resources in the Karimama district. Therefore, local people's perception on erosion and soil degradation causes in this part of Benin was investigated.
Results showed that according to local people, the major causes of erosion are deforestation (75% of interviewed persons) and farmer settlement on farms (89% of interviewed persons). Erosion factors were slope, run-off and the unsuccessful land cover and land use practices for agriculture. Concerning the erosion and soil degradation factors, we noticed a well structured perception according to the ethnic groups. Old Haussa and Adult Fulani often cited the soil type as the factors that determine the soil degradation whereas Young Gourmantché and young Haussa pointed out the run-off and the slope. Complementing this work, in 2009 local people's perception on climatic factors as (i) rainfall scarcity and agressivity, (ii) wind and (iii) temperature were assessed. According to ethnic group perception, determination of climatic factors will be completet and the contribution of each climatic factor in erosion and soil degradation will be clarified.
Many species are spared in the Karimama district according their socio economic importance. Some of them are used to: (i) restore soil fertility, (ii) feed animals and men, (iii) improve income and for therapeutic use.
For the choice of appropriate species for soil restoration, a participatory approach has been use to identify species and test their capacity to grow on degraded soils.
For plantation activities, 72 saplings of each of the following species were used: *Jatropha curcas, Parkia biglobosa, Moringa oleifera, Khaya senegalensis* and *Balanites aegyptiaca*. The total area of plantation was 1 ha.
The highest survival rates were obtained with *Jatropha curcas* et *Balanites aegyptiaca* (100%) and *Khaya senegalensis* (88,89%) on all treatments. *Parkia biglobosa* presents the lowest survival rate (71,53%), but it is still high. Considering first tendency, all these species can be proposed for soil restoration in the W national Park and surrounding areas.

Work performed by University of Ouagadougou

The study was conducted in the Northern Sudanian (Gampéla near Ouagadougou) and the Sub-sahelian zones (Baporé near Ouahigouya) of Burkina Faso. To develop appropriate restoration strategies for the rehabilitation of degraded sites in climatic zones, we combined soil and water conservation strategies with the regeneration (plantation and direct sowing) of highly valued socio-economically important species.
When choosing the species, literature and participatory approach (socioeconomic importance) were used to identify the most important species. Five species (3 species per zone, with one common species) were chosen: *Combretum micranthum* and *Jatropha curcas* for the north-sudanian zone, *Acacia senegal, Pterocarpus lucens* for the sub-sahelian zone and *Faidherbia albida* as a common species for the 2 climatic zones. In total, 480 saplings were planted in each ecological zone, and the total area of these plantations is about 3 ha.
After choosing the species, experiments were conducted in the nursery to test drought tolerance and the capacity of the chosen species to adapt to water stress.

The result showed that apart from *Pterocarpus lucens*, which cannot tolerate high stress levels, all the others species can survive a long time under hard drought (20% for *A. senegal*, 30% *F. albida* and 40% for *J. curcas* under highly severe drought).
According to results, apart from *Pterocarpus lucens*, all species can be used in degraded soil restoration. So, for the **sahelian zone, *Acacia Senegal* and *Faidherbia albida*** are the best species, and in the **soudanian zone, *Combretum micranthum*, *Jatropha curcas*** and ***Faidherbia albida*** are the best species to grow on degraded soil.

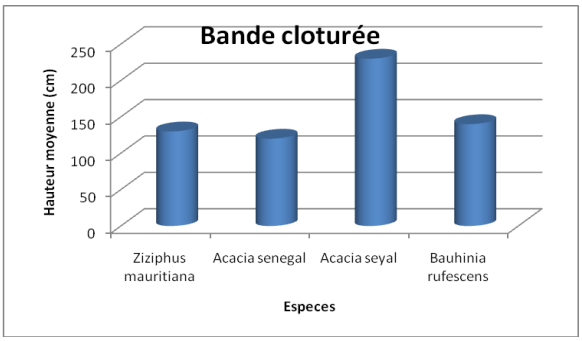
Work performed by University of Niamey

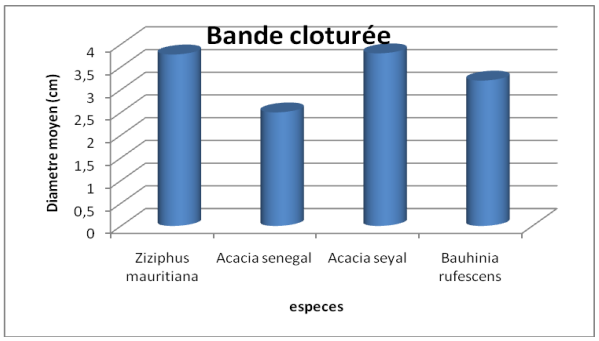
Experiments on restoration were performed in the Tamou region (soudanian zone) using high value woody and herbaceous species chosen in a participatory approach. A total of 3 ha were planted, using 36 saplings of each of the following woody species: *Acacia senegal*, *A. nilotica*, *A. sieberiana*, *Bauhinia rufescens* and *Ziziphus mauritiana.* Additionally, seeds of herbaceous species were spread: *Pennisetum pedicellatum*, *Schyzachyrium exile*, *Zornia glochidiata* (annual species), *Andropogon gayanus*, *Cymbopogon schoenanthus* (perennial species).
After 2 years of measurements, the best survival rates in the fenced plots were recorded with *Acacia senegal* (66%) and *Bauhinia rufescens* (58%) followed by *Ziziphus mauritiana* (30%) and *Acacia seyal* (16%).

Table 8.1: Survival rates of species in 2009

	Fenced plots			**Control plots**		
Species	**Number of saplings**	**Number of alive saplings**	**Survival rate (%)**	**Number of saplings**	**Number of alive saplings**	**Survival rate (%)**
Acacia. senegal	36	24	66,67	36	20	**55,55**
Acacia seyal	36	6	16,67	36	5	**13,88**
Ziziphus mauritiana	36	11	30,56	36	8	**22,22**
Bauhinia rufescens	36	21	58,33	36	21	**58,33**
Total	**144**	**72**	**50**	**144**	**54**	**37,5**

Concerning growth, there is not a clear tendency; but in the fenced plots we can see that *Acacia seyal*, *Bauhinia rufescens* ,and *Ziziphus mauritiana* seem to have the highest growth.





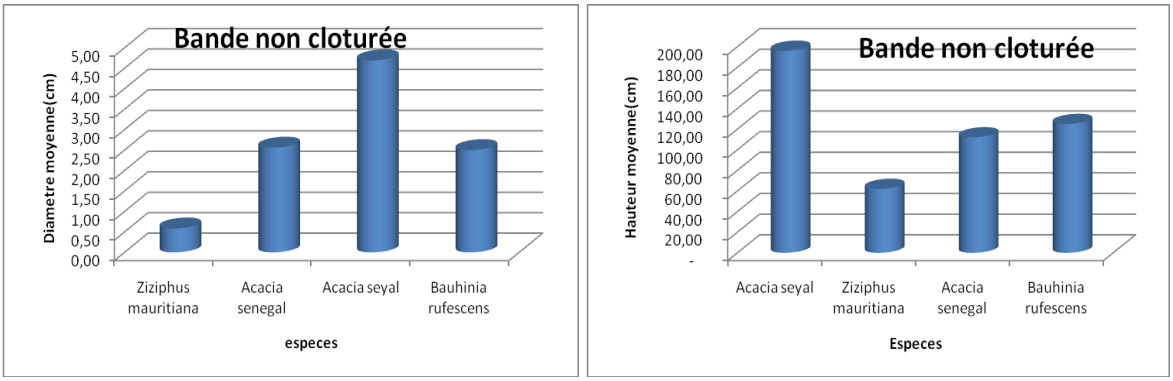


Figure8.1: Growth in height and diameter of planted species in 2008; (a) fenced plots; (b) fenced plots; (c) control plots; (d) control plots

Considering these results, *Bauhinia rufescens and Acacia Senegal* are the best species to be used for soil restoration in the Tamou region of Niger.

D8.2 Report on best low-budget techniques for reintroducing native woody species on degraded land.

Different techniques have been used in experimental sites, but they are 2 types:
- the traditional (low-cost budget): zaï, stone walls, half-moon
- the modern: deep ploughing

Work performed by the University of Bobo

Experiments were conducted in different habitats in the soudanian zone in order to restore soil fertility for better crop production. For that, 3 treatments were used: Forestry zaï, Stone walls and Control plots.

Forestry zaï treatment is the best technique, improving diversity and cover of species followed by the stone walls.

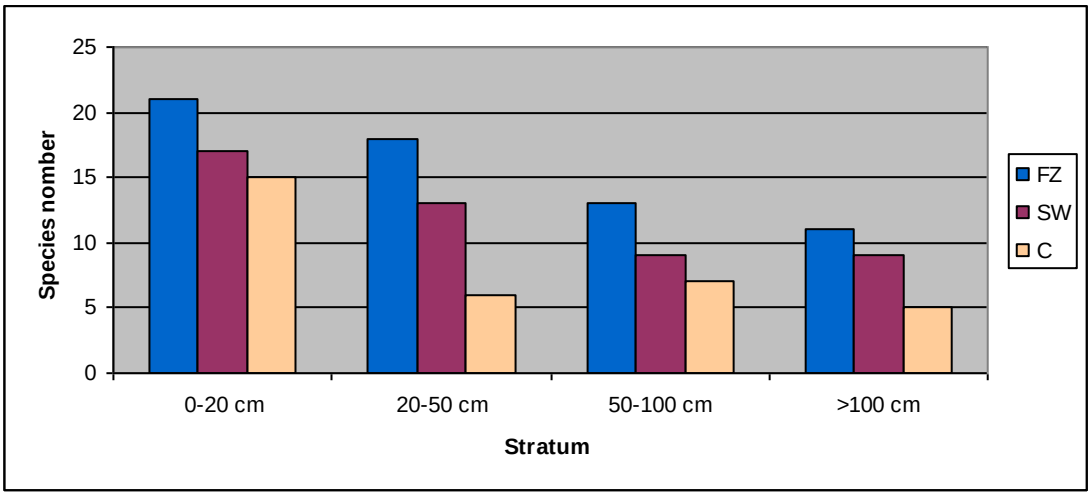


Figure 8.2: Vertical variation of the biodiversity according to soil treatments

The assessment of the phytomass shows that managements allow a meaningful development (P <0.05) of vegetation (table II). It reveals a better production increase for forestry zaï (463,7 MS/m2) followed by stone walls (384,51 MS/m2) in comparison to the control (270,63 g of MS/m2).

Table 8.2: Average production of phytomasse

Treatments	Years		Average
	2008	2009	
Control	282b	259,25c	270,63c
Forestry zaï	410,25a	517,14a	463,7a
Stone walls	352,87a	416,15b	384,51b

It is clear at this step of experiments that these low-budget techniques (Forestry Zaï, stone walls) can be proposed for soil restoration.

Work performed by the University of Cotonou

The capitalisation of the different cultivation techniques used in the Karimama district has been done. Orthogonal ploughing to the slope, crop rotation, bottom slope cultivation, and rock rows are the main cultivation techniques. Most of farmers practiced ploughing orthogonally to the slope, crop rotation and developed cropping at the bottom of slope. According to local people, tillage, poor fertility and low permeability of soil are the major adaptation reasons for those cultivation techniques. Other traditional techniques were well known by the main ethnic group (Dendi/Djerma, Fulani, Gourmantché and Haussa) of Karimama, like "half moon" and Zaï. According to their capacity to conserve water for the plants, they were suggested and tested. Three experimental plots were installed at Goroubéri (degraded land use area), Baru (Birni-Lafia) in donga and in W National Park near Kofounou in donga. The main criterion for choosing those plantation plots was the disponibility of pioneer peasant near the plantation site to go against animal grazing and Fulani damage to plants.
Traditional techniques like "half moon" and Zaï were used with no management plot (control). The following table presents the status of different species planted in 2009.

Table 8.3: Survival rates (%) of species 3 months after plantation

Species	**Control**	**Half-moon**	**Zaï**
Khaya senegalensis	83,33	95,83	87,5
Jatropha curcas	100	100	100
Moringa oleifera	70,83	97,92	77,08
Parkia biglobosa	68,75	77,08	68,75
Balanites aegyptiaca	100	100	100
Mean	**84,58**	**94,17**	**86,67**

Considering results of the above table, half-moon is the best technique, with more than 94 % of survival rate, followed by the zaï technique. At this step of data collection, the real impact of different treatments is not clear and requires an additional rainy season.

Work performed by the University of Ouagadougou
The criteria used to identify the restoration techniques are their capacity to improve soil structure, to increase soil water content or to restore soil mineral and organic characteristics. Considering literature, two traditional techniques (zaï system (Zaï), half-moon (HM)) and one modern technique (deep ploughing (DP)) were chosen.

In order to find best techniques for the reintroducing of native woody species on degraded land, a restoration test was done on each site, combining these soil and water conservation methods (deep ploughing (DP), half-moon holes (HM), zaï system (Zaï) and control (T0)) with the plantation of three high value species in each climatic zone.
The experimental designs were established in June 2008 using a Randomized Complete-Block Design, including three replicate plots of 15m x 13m with the following treatments for each species: T0 (control) without treatment; DP (deep ploughing); HM (half-moon) and Zaï. Measurements concerned soil moisture, species survival and growth and natural vegetation recruitment.

Results concerning soil moisture can be summarized in the tables 8.4 and 8.5, respectively, in August and October, 2009.

Table 8.4: Soil mean moisture (%) in August 2009 in Gampéla station

Depth	T0	Zaï	DP	HM
0-10	8,92±2,01(c)	10,33±1,01(bc)	11,39±1,09(b)	15,39±1,29(a)
10-20	7,91 ±1,63(c)	8,09 ±1,03(c)	10,91± 1,33(b)	14,48±0,67(a)
20-30	7,85 ±,68(c)	7,81 ±0,68(c)	9,46± 0,99(b)	14,42±0,86(a)
30-40	7,79±0,65(c)	7,86±0,78(c)	9,42±1,16(b)	14,35±0,4(a)
40-50	7,85±1,01(c)	7,85±0,56(c)	9,44± 0,93(c)	14,36±0,61(a)

Table 8.5: Soil mean moisture (%) in October 2009 in Gampéla station

Depth	T0	Zaï	DP	HM
0-10	4,82±1,28(c)	4,63±1,4(c)	7,59±1,09(b)	9,39±0,81(a)
10-20	5,91± 0,67(c)	6,09± 1,63(c)	9,91± 1,03(b)	12,28±1,03(a)
20-30	7,89± 0,85(c)	7,83± 0,68(c)	10,46± 0,99(b)	14,82±1,08(a)
30-40	7,87±0,5(c)	7,89±0,95(c)	10,82±1,16(b)	14,855±0,78(a)
40-50	7,84±0,09(c)	7,85±0,6(c)	10,44± 0,93(b)	14,86±0,56(a)

In the soudanian zone (Gampéla), the soil moisture increases with depth until 20-30 cm in all the treatments in August and becomes constant after this time. The values are high in the HM treatment followed by DP. However, in October, soil moisture decreases slowly in depth, but increases in values, particularly in HM treatment from 20-30cm deep comparatively to August.
In the sahelian zone (Baporé), the same tendency has been recorded. So, the high values of soil moisture have been recorded in half-moon (HM) plot followed by Deep ploughing (DP) in the two climatic zones.

The tables 8.6 and 8.7 show the impacts of treatments on species survival and growth

Table 8.6: Survival rate of the planted species after two years

Species	T0	Zaï	DP	HM
C. micranthum	20±5(b)	10±5(b)	85±10(a)	90±5(a)
J. curcas	25 ± 5(c)	0(d)	70± 15(b)	95±5(a)
***F. albida* (gampéla)**	0(d)	0(d)	15± 5(b)	90±10(a)
***F. albida* (Baporé)**	35±5(c)	35±10(c)	45±10(b)	75±5(a)
A.senegal	65±10(b)	60±5(b)	70± 5(a)	80±0(a)
P. lucens	5± 0(a)	0(b)	10±0(a)	15±5(a)

Table 8.7: Impact of techniques on height growth during the first rainy season

Species	T0	Zaï	DP	HM
C. micranthum	12,17±1,92(c)	13,03±1,93(c)	20,79±1,65(a)	16,04±1,17(b)
J. curcas	8,64 ±1,12(c)	18,24± 5,25(a)	12,07± ,86(b)	8,62±1,69(c)
***F. albida*(gampéla)**	0,62± 0,18(a)	0,64± 0,2(a)	0,81± 0,26(a)	0,62±0,23(a)
***F. albida* (Baporé)**	0,64±0,17(b)	0,41±0,19(b)	2,96±0,6(a)	3,54±0,61(a)
A.senegal	4,31±1,52(b)	4,7±1,48(b)	12,91± 1,26(a)	14,07±1,56(a)
P. lucens	1,08± 0,62(b)	1,14± 0,59(b)	3,44±0,57(a)	3,04±0,49(a)

The survival rates (Table 8.6) reveal the best impact of half-moons (HM) technique followed sometime by deep ploughing which offers better conditions for plants. Results on height growth show variable effects of treatments on seedlings growth. At the end of the first rainy season, results show a significant effect of the treatments on the development of the seedlings, in particular Zaï for *Jatropha curcas*, HM (half-moons) and deep ploughing (DP) for *Faidherbia albida* (sahelian zone), *Pterocarpus lucens*, *Acacia senegal* and *Combretum micranthum*. However, techniques have no significant effect on *Faidherbia albida* planted in Gampela.

Vegetation survey and biomass assessment have been done in September, 2009. For each plot in each zone, we recorded grass cover using Braun-Blanquet method, species richness and we also assessed biomass. The following tables (Table 8.8 and 8.9) present the results.

Table 8.8: Natural vegetation recruitment after two years following management techniques in Gampéla (soudanian zone)

Parameters	T0	Zaï	DP	HM
Cover (%)	1±0,5(c)	2±0,5(c)	20±4,08(b)	45±3,56(a)
Species number	5,5±0,91(d)	11,5±2,12(c)	20,33±5,51(b)	32,25±5,76(a)
Biomass (Kg/ha)	11,389(d)	66,805(c)	273,750(b)	396,861(a)

Table 8.9: Natural vegetation recruitment after two years following management techniques in Baporé (sahelian zone)

Parameters	T0	Zaï	DP	HM
Cover (%)	1±0,5(b)	1,5±0,5(b)	45±5(a)	35±5(a)
Species number	5±1,41(c)	10,5±4,95(b)	30,63±0,58(a)	26,5±4,24(a)
Biomass (Kg/ha)	22,500(b)	34,722(b)	495,833(a)	414,306(a)

Natural recruitment following treatments shows variable effect of techniques. In Gampéla (Table 8.8), the half-moon technique offers high values for all the parameters followed by deep ploughing, and we have no significant difference between Zaï and control. However, in Baporé (Table 8.9), we see the same tendency dominated by deep ploughing, but no significant difference between deep ploughing and half-moon.
Considering all results, **half-moon and zaï** are the best low-budget techniques for soil restoration, but deep ploughing is the best and requires more financial efforts.

Work performed by the University of Niamey
Deep ploughing was used for soil treatment; one of the plots was fenced against animals and the other was the control. Results showed that this technique obviously is good for soil restoration, but it still is expensive. In order to improve soil restoration, protection of sites is important. Results

clearly show that species survival, growth and species richness are better in fenced plots compared to control.

Table 8.10: herbaceous species richness in experimental plots in 2009

Family	Number of genera	Species	Fenced plots		Control plots	
			Frequency	Specific contribution (%)	Frequency	Specific contribution (%)
CAESALPINIACEAE	2	*Piliostigma reticulatum*	12	13,48	6	7,23
		Bauhinia rufescens	21	23,60	21	24,70
COMBRETACEAE	3	*Combretum nigricans*	0	0,00	2	2,41
		Combrethum micranthum	0	0,00	1	0,6
		Combretum glutinosum	0	0	1	1,20
		Guiera senegalensis	9	10,11	12	14,46
		Terminalia mantaly	0	0	2	2,41
RUBIACEAE	1	*Gardenia sokotensis*	0	0	2	1,18
MIMOSACEAE	1	*Acacia ataxacantha*	0	0,00	0	0
		Acacia macrostachya	6	6,74	6	6,63
		Acacia. senegal	24	26,97	20	24,10
		Acacia nilotica	0	0,00		0
		Acacia seyal	6	6,74	5	5,42
RHAMNACEAE	1	*Ziiziphus mauritiana*	11	12,36	8	9,10
Total			**89**	**100**	**83**	**100**

Work to perform
- Data collection will continue in the next months in order to monitor species capacity to grow on different treatments
- Soil final analysis in order to assess the impact of managements
- Last data collect and analysis
- Writing of the last scientific papers

Constraints
- Insecurity of plots, some plots were lost because of fire
- High cost of using machines for some treatments
- High cost of soil analysis
- Short duration of the project

D8.3 Analysis of socio-cultural acceptance of developed techniques.

Choice of species and techniques has been done with participatory approach. During the experimentations, populations were associated in order to make easier technique adoptions. Data recording is done with help and interest of surrounding populations. At this stage, some peasants are well informed on the best techniques. At the end of the experimentation, the adoption will be easy and restitution will be done in a workshop. Adoption of developed techniques will be easy because the pioneer peasants can assume dissemination activities.

The University of Ouagadougou
Social and cultural acceptance of the developed practices is a precondition for their sustainability. In the frame of the SUN project, and especially concerning restoration activities (WP 8), we have conducted analysis of socio-cultural acceptance of developed techniques for soil and vegetation restoration. This activity was carried at the end of experiences from 17 to 18 August, 2010, by the

WP leader (Pr A. Thiombiano), the socio-economist (Dr A. Senghor), the student supervisor (Pr J. Boussim) and the student (F. W. Kagambèga).
In this survey, the assessment of socio-cultural acceptance is concentrated on respect for local habits and belief systems, including the used species. The assessment of social acceptance comprises the attitudes of old and young people in regard to the extent of degraded land, changes in vegetation cover, sustainable use of natural vegetation, effects of the developed techniques, the relevant techniques and their duplication process.
The analysis concerned the population of the two villages in which the restoration experiments were carried out. A total of 40 and 45 peasants were interviewed, respectively, in Baporé (Ouahigouya region) and Gampèla (in Ouagadougou region) comprising all ages (from 18 to 60 years) and taking gender issues into account (men and women).
In each village, after presenting the team, an introduction was given to describe the process of the analysis. To avoid influencing the perceptions of populations, we have first asked questions concerning land degradation in their areas and activities we have conducted in the study sites. We highly considered gender issue, so that answers really took into account the interest of everybody. In total, 10 questions were addressed to the population, which focussed mainly on soil degradation and restoration. Corresponding answers will be given for each question.
1. What is your perception about the extension of degraded land as sealed bare soil in your area?
We are conscious that degraded lands expand more and more compared to the past. Additionally, resources are decreasing and it is very difficult to find some species in our areas nowadays.
2. Do you use any technique to restore degraded soils?
We usually use techniques like zaï, stone rows, mulching and tree plantation to restore soils.
3. What are the plant species you use for plantations?
To restore or to combat land degradation we usually use exotic species such as Eucalyptus sp, Azadirachta indica and recently Jatropha curcas because they grow rapidly and they are available in nurseries.
4. According to your perception, is it possible to use local species in plantation activities?
According to most of them it is not possible to use local species. Some of them think that it's possible, but the difficulties are the slow growth compared to Eucalyptus sp and seedling production. The last did not know that all local species can provide seeds for nurseries.
5. Considering local plant species, which do you prefer for plantations and why?
Considering experimental results, socio-economic and ecological importance (Soil fertilization, firewood, craft industry, pharmacopeia, bio-energy. etc.) of species, the preferred species are Combretum micranthum, Parkia biglobosa, Faidherbia albida, Jatropha curcas, Tamarindus indica, Piliostigma reticulatum, Anogeissus leiocarpa for Gampèla's people and Acacia Senegal, Faidherbia albida, Pterocarpus lucens, Jatropha curcas for Baporé's people.
6. Are you informed about our restoration activities carried in your village?
Yes we are well informed.
7. What is your opinion about these experiments considering main results on the field?
We think that the experiment is very helpful because before the trial, the soil was bare, and now vegetation appears. Additionally, we didn't know that it was possible to use local species to restore degraded ecosystems.
8. How do you perceive changes in experimental sites regarding improvement of vegetation cover and plant survival?
We can really see changes in time because now we notice that spontaneous vegetation appears and soil is becoming fertile. It is possible now to grow something here compared to the past when the soil was completely infertile. Experiments show also that planted species are really able to grow in such difficult conditions. Now, we can have forage for animals, soil for agriculture and wood for fire and other needs.
9. According to results and your observations, what are the best techniques for soil and vegetation restoration?

Considering cost and results, all of interviewed agreed on the best performance of half-moons followed by zaï. Deep ploughing is the best, but very expensive in the context of farmers.
10. Are you ready to disseminate techniques and results in other villages and to apply these techniques in your fields?
After this trial, we are ready to use local species now. Most of us are ready to duplicate all the techniques except deep ploughing because of its high cost. We need technical manuals and teaching for best duplication.

Photo 8.1: part of the UO team with population of Gampéla

Photo 8.2: Student with population of Gourga (Ouahigouya)

Constraints
Local populations are well sensitized to benefits of techniques, but at least minimum funding availability is required. For sensitization activities, workshops need to be held in the dry season (from February to April) when populations are free from field activities.

The University of Niamey
Similarly, a meeting was organized in Niger with local populations to explain results on restoration techniques (Photo 8.3 and 8.4).

Photo 8.3: local population of Tamou region

During the workshop

Photo 8.4: team of University of Niamey
explaining results

D8.4. Manual on appropriate vegetation restoration methods with native species.

The University of Ouagadougou
Based on activities and results, we have written 3 manuals on techniques used during the project for soil restoration:

TECHNICAL MANUAL N°1

By Kagambèga W.F., Bayen P., Thiombiano A. & Boussim I.J

Restoration of degraded land using half-moon technique

Half-moons digged on a sealed bare soil “zipellé”

Domain:

- Rehabilitation of degraded land
- Soil and water conservation

Objectives:

- Increase infiltration and soil water content
- Improve soil fertility
- Regenerate encrusted soil
- Restore soil productivity
- Increase arable land

Description:

Half-moons technique is a water collection device, implemented on bare and crusted soils with gentle slopes

• Half-moons are installed perpendicularly to the slope on contour line;

• The basins are dig 10–15 cm depth done with a hoe or a pick to break the crusted layer of the soil surface, and to collect the runoff water; while the top 0-15 cm excavated soil is used to form a bund around a half-circle.

• Half-moons have 2 m diameter; spaced about 1 m between two half-moons within the same contour and by 3 m between two successive lines.

Jatropha curcas seedlings in half-moons circles

Performance:

After two years experimentation:

• With half-moon treatment in the sudanian region (Gampéla) natural vegetation recruitment is about 45% cover, species richness is about 32 and the total biomass is about 3997 kg/ha. In the subsahel region (Baporé) vegetation cover is 35%, 26 for species richness and 415kg/ha for biomass.

• considering plantations, the survival rates at Gampéla are 90±5% for *Jatropha curcas* and *Combretum micranthum*, 85±10% for *Faiderbia albida* and at Baporé 60±15% for *Faiderbia albida*, 60±5% for *Acacia Senegal* and 20±5% for *Pterocarpus lucens*.

Spontaneous regeneration in half-moons

TECHNICAL MANUAL N°2

By Kagambèga W.F., Bayen P., Thiombiano A. & Boussim I.J

Restoration of degraded land using deep ploughing technique

Deep ploughing realisation using a tractor

Description:

It is a technique consisting in tilling the soil deeply in order to break the sub-soil using a bulldozer or a tractor; it aims to burst the ground (up to 50 cm) in order to allow roots penetration and water infiltration:

• Furrows are installed perpendicularly to the slope;

• it is done using a tractor named "*Delphino"* and the furrows are 40-60 cm depth;

• the furrows are spaced about 3m.

Performance:

After two years experimentation with deep ploughing technique:

- at Gampèla spontaneous regeneration is 20,4% of cover, species richness about 20 and 274 kg/ha for the biomass. At Baporé vegetation cover is about 45%, 31 for species richness and 496 ka/ha for biomass.

- Considering plantations at Gampéla, survival rates are 45±15% for J*atropha curcas*, 88±5% for *Combretum micranthum*, 10±0% for *Faiderbia albida*. At Baporé 20±5% for *Faiderbia albida*, 45±5% for *Acacia Senegal* and 10±5% for *Pterocarpus lucens*.

Domain:

- Rehabilitation of degraded land
- Soil and water conservation

Objectives:

- Increase water infiltration and plant roots penetration
- Improve soil fertility
- Regenerate encrusted soil
- Restore soil productivity
- Increase arable land
- Increase vegetation cover

Combretum micranthum saplings in deep ploughing furrow

Spontaneous regeneration in deep ploughing

TECHNICAL MANUAL N°3

By Kagambèga W.F., Bayen P., Thiombiano A. & Boussim I.J

Restoration of degraded land using Zaï technique

Zaï pits digged on a sealed bare soil “zippélé”

Domain :

- Rehabilitation of degraded land
- Soil and water conservation

Objectives :

- Improve soil fertility
- Increase infiltration and water stock in the soil
- Recover encrusted land for agro-sylvo-pastoral activities
- Increase arable land

Description

Zaï practice is a traditional technique used in the Sahel in West Africa for the rehabilitation of degraded and crusted soils

• It consists to dig manually small pits (20 to 40 cm in diameter and 10 to 20 cm in depth) during the dry season.

• Zaï pits must be done on separate lines perpendicularly to the slope.

• The excavated soil is put in the downstream section of the slope to collect runoff water and each pit receive a handful of organic matter (300 to 600 g)

• Zaï pits are spaced about 0, 80 m x 0, 40 m for sorghum cultivation and 0, 60 m x 0, 60 m for millet cultivation.

• Millet or Sorghum sowing is done directly in the pits.

Performances

• With the Zaï pits only (without fertilizers): the grain yield is very weak (less than 100 kg/ha).

• Utilization of 460 g of compost in each pit gives an important yield in grain (383, 10 kg/ha).

• Spontaneous vegetation is about 10% after 3 years

Application conditions

• Soudano-sahelian zone with 400 to 900 mm of rainfall;

• Have a good quality of organic matter

Sorghum in zaï pits

Sorghum seedlings after two months

Sorghum in ripening stage

Milestones

First, results on **success of experiments** (e.g. survival/growth rate) and modifications (month 21).

First, results on experiments in different ecological zones show that some species present good survival rates after 2 years: *Acacia Senegal, Faidherbia albida, Combretum micranthum, Jatropha curcas, Acacia senegal and Bauhinia rufescens*. For other species, more data are needed to show a clear tendency: *Parkia biglobosa, Moringa oleifera, Khaya senegalensis and Balanites aegyptiaca*. There is more success in the soudanian zone than in the sahelian according to species survival.

Modifications concern the team of Bobo Dioulasso who carried activities on field restoration for more crop production using some of the chosen restoration techniques.

Expected result

Manuals will be disseminated in different associations, NGOs, and through local population organisations.

WP9 Dissemination

Prof. Ali Mahamane, Partner 10

Participants: P1 Aarhus, P2 Dias, P3 Dakar (44), P4 Frankfurt (58), P5 Senckenberg, P6 Ouagadougou, P7 Bobo, P8 Cotonou, P9 Joint Research Center of Ispra, Italy, P10 Niamey

WP objectives:
The overall objective of this package is to ensure efficient dissemination of project results at all levels.

The specific objectives are:
To establish and run a homepage.
To extend the network of scientific expertise (ABAO) in West Africa and make the information accessible from the Internet.
To follow-up and sum-up results from contacts to advisory board.
To follow the establishment of centres of expertise in core areas (WP1, WP7, WP8).
To ensure training courses for students and managers provided by SUN staff (all WP).
To follow the publication of results in scientific journals (all WP).
To ensure general publicity of the project activities and results, especially after each workshop.

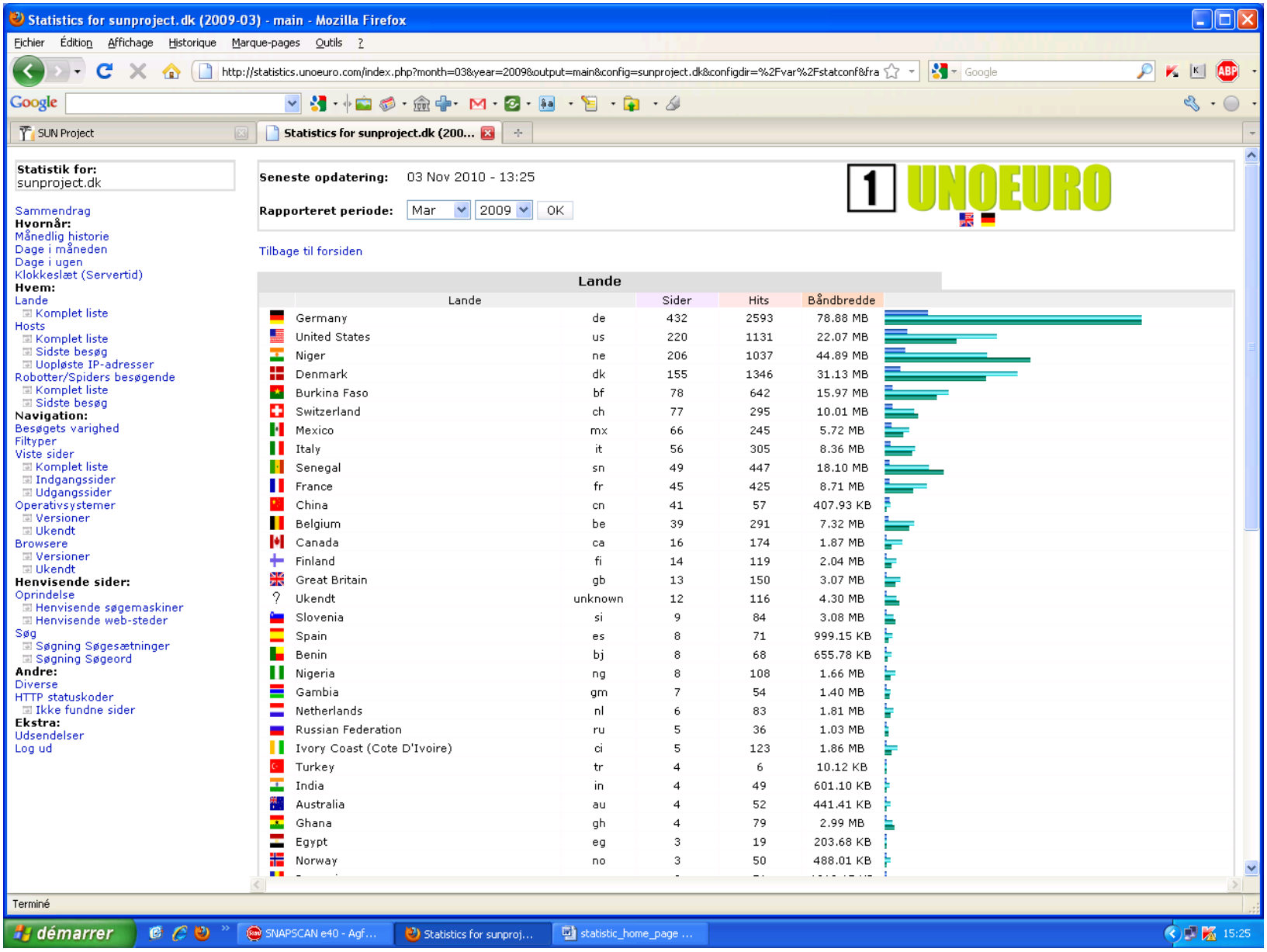
Deliverables

D9.1 A continuously updated homepage.

The homepage is running and regularly updated. The updating of the homepage will continue in order to include references published after project finalisation.

D9.2 Internet access to network of scientific expertise.

The number of visits amount to 1650 in 2009 and 1537 in the first quarter 2010. This re-releases renewed interest of the scientific world in our site. Apart from the member countries of the network, the browsers from which the searches are operated are from following countries: Germany, United States, Switzerland, Mexico, Italy, France, China, Belgium, Canada, Finland, Great Britain (Fig. 9.1 and Fig. 9.2). During the first quarter of 2010, searches from China occupy the second position in visits to the homepage (Fig. 9.2). The number of countries that have visited the homepage is 61 in 2009 and 64 between January and March 2010. Throughout the years, the homepage is visited with peaks during February-March and September-October (Fig. 9.3).


Statistics for sunproject.dk (2009-03) - main - Mozilla Firefox
Fichier Édition Affichage Historique Marque-pages Outils ?
http://statistics.unoeuro.com/index.php?month=03&year=2009&output=main&config=sunproject.dk&configdir=%2Fvar%2Fstatconf&fra
SUN Project
Statistics for sunproject.dk (200...
Statistik for:
sunproject.dk
Sammendrag
Hvornår:
Månedlig historie
Dage i måneden
Dage i ugen
Klokkeslæt (Servertid)
Hvem:
Lande
Komplet liste
Hosts
Komplet liste
Sidste besøg
Uopløste IP-adresser
Robotter/Spiders besøgende
Komplet liste
Sidste besøg
Navigation:
Besøgets varighed
Filtyper
Viste sider
Komplet liste
Indgangssider
Udgangssider
Operativsystemer
Versioner
Ukendt
Browsere
Versioner
Ukendt
Henvisende sider:
Oprindelse
Henvisende søgemaskiner
Henvisende web-steder
Søg
Søgning Søgesætninger
Søgning Søgeord
Andre:
Diverse
HTTP statuskoder
Ikke fundne sider
Ekstra:
Udsendelser
Log ud
Seneste opdatering: 03 Nov 2010 - 13:25
Rapporteret periode: Mar 2009 OK
UNOEURO
Tilbage til forsiden
Lande
Lande Sider Hits Båndbredde
Germany de 432 2593 78.88 MB
United States us 220 1131 22.07 MB
Niger ne 206 1037 44.89 MB
Denmark dk 155 1346 31.13 MB
Burkina Faso bf 78 642 15.97 MB
Switzerland ch 77 295 10.01 MB
Mexico mx 66 245 5.72 MB
Italy it 56 305 8.36 MB
Senegal sn 49 447 18.10 MB
France fr 45 425 8.71 MB
China cn 41 57 407.93 KB
Belgium be 39 291 7.32 MB
Canada ca 16 174 1.87 MB
Finland fi 14 119 2.04 MB
Great Britain gb 13 150 3.07 MB
Ukendt unknown 12 116 4.30 MB
Slovenia si 9 84 3.08 MB
Spain es 8 71 999.15 KB
Benin bj 8 68 655.78 KB
Nigeria ng 8 108 1.66 MB
Gambia gm 7 54 1.40 MB
Netherlands nl 6 83 1.81 MB
Russian Federation ru 5 36 1.03 MB
Ivory Coast (Cote D'Ivoire) ci 5 123 1.86 MB
Turkey tr 4 6 10.12 KB
India in 4 49 601.10 KB
Australia au 4 52 441.41 KB
Ghana gh 4 79 2.99 MB
Egypt eg 3 19 203.68 KB
Norway no 3 50 488.01 KB
Terminé
démarrer
SNAPSCAN e40 - Agf...
Statistics for sunproj...
statistic_home_page ...
15:25