Overview of Management of Natural and Environmental Resources for Sustainable Agricultural Development in France

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Abstract

Agriculture plays an important and double role in environmental and natural resources. Agriculture contributes to degradation but at the same time can help to preserve and restore resources. In France and in many other countries, intensive cultural practices have contributed to soil and water degradation (pollution, acidification, erosion). With climate change and the increase of natural disasters, degradation will become a major problem in the next few years. In France, some measures have been taken for agriculture with the installation of the Sustainable Agricultural Contract (Contrat d'Agriculture Durable or CAD) that farmers sign with government. At the same time, tools for monitoring and forecasting main risk factors have been developed for better management and protection of natural and environmental resources.

Introduction

Soils comprise one of the three components of the biosphere along with water and the atmosphere that are essential for biological activity and earth biodiversity. They have many functions that can be modified because of natural factors but also from human activities such as agricultural and industrial development. Disruptions of the natural balance can produce long-term degradations in soils, (pollution, erosion, acidification, salinization), water (pollution, eutrophisation), and atmosphere (pollution, disasters). In France, soil and water are sources of concern. Pollution, the heat wave in 2003, and drought in 2005, have raised awareness of the value of water. Natural resource degradations, and recent natural disasters (storms, floods) with potential consequences of climate change, have begun to be taken into account both at a citizen and a political scale and have resulted in protection, restoration, and monitoring of environmental resources measures.

Agriculture is one of the causes but also is directly and indirectly impacted by natural and environmental resources degradation. It is a system that must be taken into account. Sustainable agricultural development is an essential point in the natural resources preservation. Integration of environmental problems in the European Union (EU) Agricultural Policy (Common Agricultural Policy - CAP) demonstrates the importance of the subject.

Environmental Resources and Natural Disasters

The rural landscape represents 95 percent of the total area in France of which 59 percent is agricultural and 26 percent is covered in forests. From 1990 to 2000, grassland has been reduced by 0.8 percent of arable land. In 2003, artificial surfaces (man-made surfaces such as roads, houses, etc.) occupied 8 percent of the territory. Between 1993 and 2003 artificial surfaces increased by more than 15.6 percent, mainly to the detriment of agricultural land and natural

areas (IFEN, 2005). Very often this use of artificial surfaces is an irreversible alteration of soils that contribute to the reduction of biodiversity.

Soil Degradation

Soil degradation is an important issue for sustainable agricultural development. The loss of soil function effects the environment, both on a local scale (erosion, decrease of fertility, pollution), and on a large scale (reduction of the biodiversity). Soil quality has deteriorated over the last few decades, in particular in the countries affected by desertification and drought. The situation is also of concern in Europe, even if there are some regional differences. Without giving a review of the different types of soil degradation, some significant examples can show the dimension of this problem in France.

Loss of Organic Matter

Many studies have shown that organic matter rates in the soil seem to decrease in some areas of France. It is the case, for example, in Bretagne (western France) where there has been a decrease of about 0.5 percent of the organic matter rate during the last 25 years in soils where the initial rate was about 3 percent and a decrease of more than 1 percent in soils where the initial rate was about 7 percent. This is a concern because this decrease can have important environmental consequences on soil fertility, erosion, runoff, and leaching.

Soil Acidification

Soil acidification is part of the consequence of changes in agricultural practices such as the reduction of lime spreading and intensification of agriculture (increasing of nitrogen contents, decreasing of organic matter).

In France, this is especially a problem for forests in the Southwest and Northeast. During the 1970s, the yellowing of tree leaf was observed. Sulfur atmospheric deposits were thought to be indirectly responsible because of acidifying effects on soils and water. Consequences of this acidification were the withering of trees, a decrease of soil fertility, erosion resistance, biodiversity, and an eutrophisation of rivers. Nonetheless, this eutrophisation concerns almost all of France: it is estimated that 90 percent of the area of France has atmospheric deposits that cause or will cause the eutrophisation of ecosystems. A study has shown in1995 that 90 percent of rivers in the Vosges (eastern France) had some degradation because of acidification (Le Gall, 2004).

Soils Erosion

The erosion risk in France is medium to high (Figure 1). Taking into account the erosion in environmental and sustainable agricultural policy is a priority because of its irreversible nature. The main factors for water erosion are the soil and its utilization, topography, and climate. In France, there are four main types of erosion in function of the release factors (Le Bissonais, et al., 2003):

- erosion in large scale farming;
- erosion in vineyards and orchards;
- mountain erosion;
- Mediterranean coastal erosion.

Erosion brings about destruction of seedlings, loss of soil capital and fertility, and increased potential of mudslides. On a large scale, erosion also causes water pollution. Runoff is loaded with suspended matter carrying chemical components (phytosanitary products) that increase river turbidity and their content of eutrophisant products.

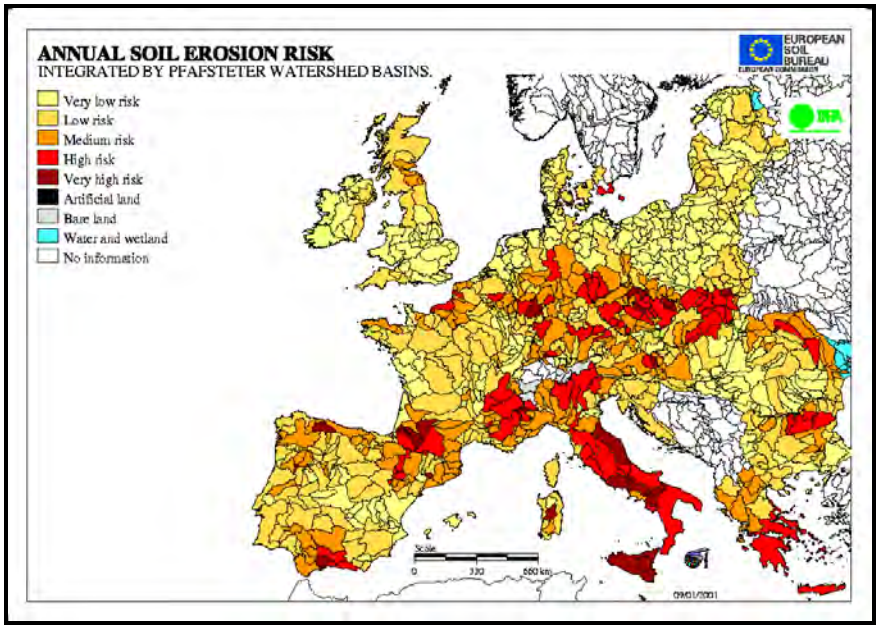

Figure 1. Annual soil erosion risk in Europe.

It is difficult to characterize quantitatively the erosive hazard. But the increased risk (defined as the product of hazard and vulnerability) is more probable. There are multiple agricultural reasons for this: the removal of hedges and ditches to extend the parcel, specialisation of crops, and reduction of grass areas. The erosion risk in France has been modelled and mapped by the French Institute for Agronomical Research – INRA (Figure 2).

The model is composed of three stages:

- Evaluation of the potential suitability of land, established from soils, slopes, and uses data;
- Evaluation of the average and seasonal risk by geographic unit (district, watershed, agricultural area) established with the potential suitability and seasonal rainfall;
- Topological zoning of the risks to localize the different types of erosion.

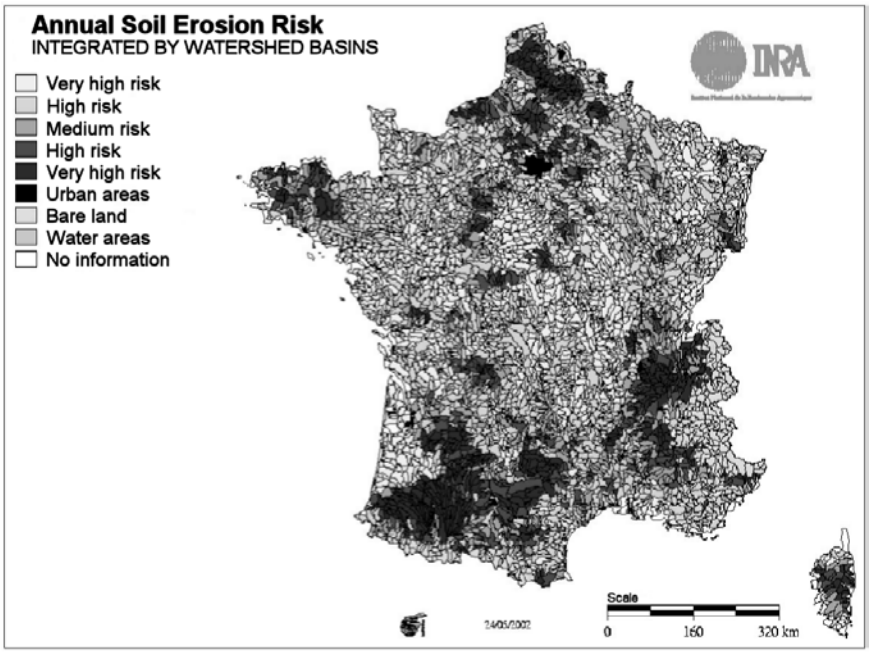

Figure 2. Erosive hazards in France.

Water Resource and Agriculture

Water management is also a big factor for sustainable agricultural development. In France, water consumption from agriculture is 30 to 40 percent of the total consumption but in the summer in can reach about 80 percent and 90 percent in the south of France. Irrigated areas have increased over the last few years: 0.5 million hectares (ha) in 1970, 1.1 million ha in 1998, and 1.8 million ha in 2003. A succession of more or less severe drought during the last 3 decades (1976, 1979, 1985, 1986, 1989, 1990, 1991, 2003, and 2005) can explain this development. Until 2003, EU agricultural policy (CAP) had encouraged irrigated production to increase productivity. But the new CAP removes or limits subsidies for irrigation. In the short term, this should lead to decreasing the total irrigated area by about 10 percent, 14 percent for corn, and water consumption in France should also decrease by about 7 percent (MEDD, 2005).

But conflicts about use of water resources are more and more frequent, in particular in 2005, where the legitimacy of irrigated corn was especially questioned. With climate change scenarios that predict a temperature increase of about 3 to 5°C in summer and at the same time a rainfall decrease of 0.1 to 1 millimeter (mm) per day, the issue of water resources will be crucial, in particular for agriculture.

Extreme Natural Events

Floods

Flood hazard is a concern in about 5 to 7 percent of the area in France, and 10 percent of the French population live in this area where the flood hazard is significant. Floods are the main risk in France and cause 75 percent of the damages (on average and financially). The average annual cost of the floods is from about 600 million Euros, and the number of floods has increased over the last few years (Figure 3 and Table 1).

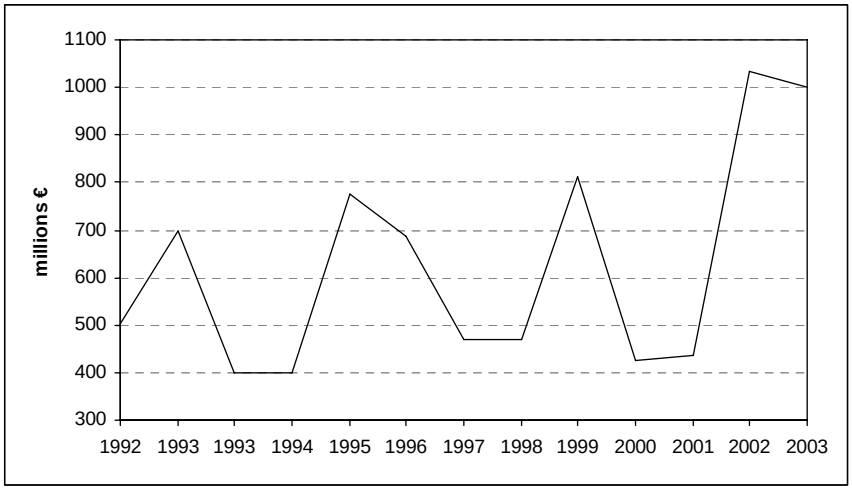

Figure 3. Indemnities paid by insurance companies for floods in France since 1992 (not adjusted for inflation).

Table 1. Major floods in France.

Date	Location	Comments
1875	South West	*200 deaths*
1910	Center (Paris)	
1930	South West	*More than 300 deaths, 10 000 disaster victims*
1940	South West	*300 deaths*
1958	South East	
1977	South West	*5 deaths*
1983	South West	*5 deaths*
1987	Alpes	*23 deaths*
1988	South East (Nîmes)	*11 deaths, 150 million Euros of damage*
1990	West end East	*180 million Euros of indemnity*
1992	South East (Vaison)	*41 deaths, 150 million Euros of damage*
1993-94	North	*21 deaths, 530 million Euros of damage*
1994	South East (Nice)	*120 million Euros of indemnity*
1995	North	*400 million Euros of indemnity*
1997	West	*65 million Euros of damage*
1999	South West (Aude)	*34 deaths, 650 million Euros of indemnity*
2001	North	*40 million Euros of damage*
2002	South East	*23 deaths, 1.2 billion Euros of damage*

The increase in flood damage can be explained by urban development through the increase in artificial surfaces (see previous section) but also by changes in agricultural practices. For example, it was estimated that if the 1905 flood of Seine River should happen again, the cost would be about 10 billion Euros, versus 1.4 billion in 1910.

Storms

Storms are very destructive for agriculture and especially for forestry. As for floods, it seems that number of storms has increased over the 2-3 decades (Table 2).

Table 2. Indemnities paid by insurance companies for storms in France since 1976 (not adjusted for inflation).

Date	**Millions Euros**
January 1976	41
December 1979	32
November 1982	440
February 1984	65
July 1984	126
October 1984	15
November 1984	45
December 1987	500
January 1990	990
February 1990	1 330
December 1999	11 500

The storm of December 1990 caused the death of 92 people and 130 million trees (132 billions m^3 of wood) were uprooted.

Impacts of Climate Change

During the last century, the temperature has increased in some areas of France up to +0,9°C and +1,5°C for maximum and minimum average temperature, respectively. Already some signs of this warming are observable, for example, in the case of the phenology of fruit trees and vines (Seguin, 2003). Several studies showed an advanced onset of vegetation since 1970 (Figure 4).

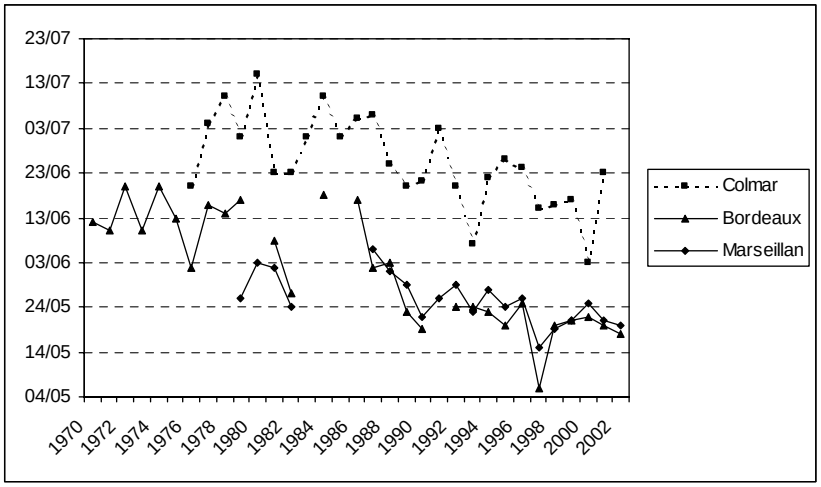

Figure 4. Flowering date of Chasselas grapes since 1970 in three locations.

For forestry, studies showed an acceleration of tree growth since the beginning of the 19th century that can be connected with the elevation of CO2 in atmosphere (Figure 5).

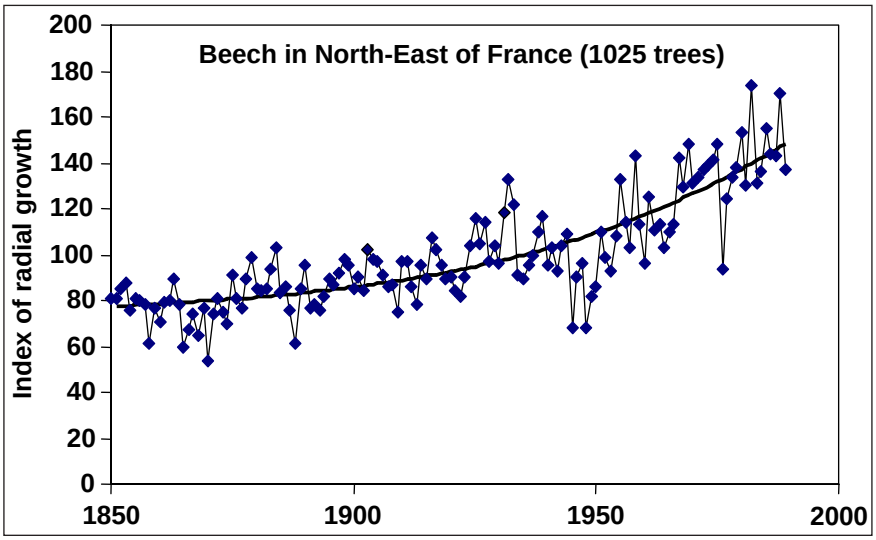

Figure 5. Growth of Beech trees in North-East France since 1850.

A consequence of climate change can already be observed in regards to bird migration. This is very important for agriculture and especially for breeding because birds are direct or indirect vectors of pathogen agents:

- birds carry ticks and associated bacteria (Borrelia burgdorferi: Lyme);
- their blood can carry viruses (West Nile, etc.);- bacteria are in their excrement (Chlamydia, Campylobacter);
- nasal secretions can carry viruses (Influenza)

For example, the migration of birds to Heligoland Island (Northern Germany) takes place 2-12 days earlier than 40 years ago. In the United Kingdom, Sparks (1999) found an advance of 1 to 2 days in the arrival of swallows per 1°C mean temperature increase and observed that:

- short migrations take place on average 1 to 4 days earlier every 10 years;
- date of egg laying is earlier;
- there is an increase of second egg laying;
- the area of southern species has moved 10 kilometers (km) northward over the last 20 years.

In the future, with response to climate change, ecosystems in France will change. Using climate change scenarios for the end of the 21st century, a map of the natural tree areas show some important modifications, with an increase of holm oak and maritime natural pine areas and a decrease of fir and chestnut (Figure 6).

On plant ecophysiology, consequences could be:

- an increase of photosynthesis activity and of biomass production;
- an acceleration of phenology (shorter cycles);
- better water efficiency.

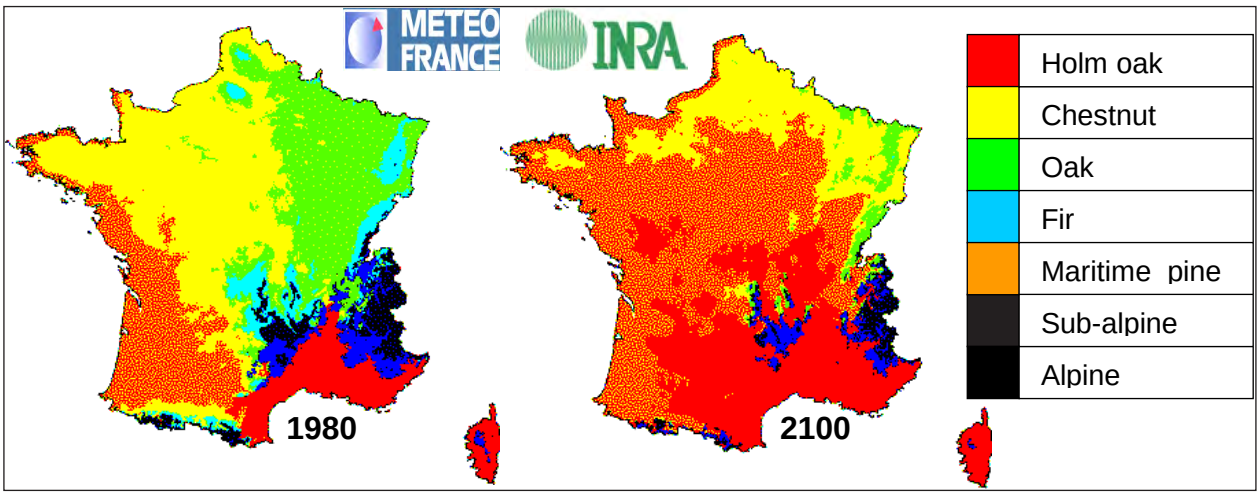

Figure 6. Natural trees areas in France in 1980 and estimated for 2100.

Public Policies and Services for Environmental Managers

Sustainable Agriculture Contract

The Sustainable Agriculture Contract (Contrat d'Agriculture Durable or CAD in French) was created in 2003 by the government to develop the various facets of French agriculture. Its aim is to increase farmer contribution to natural resources protection, rural development; and the goals are erosion mitigation, preserving soil quality, water resources, biodiversity, and landscapes.

Contracts are between farmers and the government for a period of 5 years. The contracts have two sections:

- the first is an optional socio-economic section. The upper limit is fixed at 15,000 Euros, and is to help the farmer transition to a sustainable agriculture (diversification of activities and productions, and an improvement in the quality of products);
- the second, which is obligatory, is an agro-environmental section. It pays for additional costs and loss of income resulting of the use of best practices for environment.

The CAD responds to regional problems and agro-environmental actions are adapted for each French area. In 2004, 234 million Euros have been paid and about 10,000 contracts have been signed.

Tools for Risk Monitoring and Evaluation

Monitoring of Hydrological Conditions

Since 2004, the French National Weather Service (Meteo-France) has maintained daily monitoring of water and energy balances and water flows of the main watersheds. This information is used for several diagnostic or forecast applications. For example, the soil water index (SWI) is estimated to characterize drought conditions.

SWI Index = (w – wilt) / (wfc – wilt)
With w : water in soil
wfc : field capacity
wilt : wilting point

Assistance for Wildfire Surveillance

Since 1965, more than 1 million hectares (ha) of forest land have burned in France. The average area burned each year by wild fire is about 26,000 ha, but in 2003, with the heat wave, there was more than 70,000 ha burned (Figure 7). Wildfire increases soil degradation, reduces biodiversity, and increases erosion risks. Meteo-France provides emergency services and meteorological assistance for wildfire prevention in southern France. This monitoring is based on the daily expertise of meteorological conditions and the forecast of the drought index. The risk is divided into six levels: exceptional, very severe, severe, moderate, light, and weak.

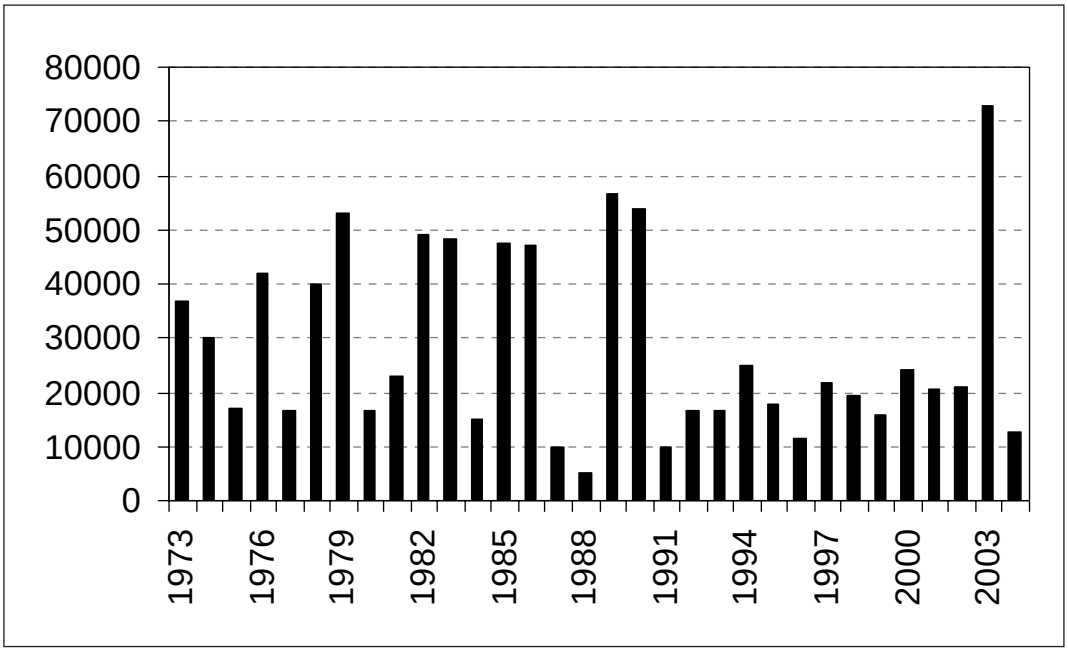

Figure 7. Forest areas burned since 1973 in France (in ha).

Tools for Agriculture and Irrigation

At the Agriculture Ministry's request, Meteo-France with the French National Institute for Agricultural Research (INRA), the agricultural technical institute and water management service, provides maps for assessment of the water needs for irrigated corn. This information is used during droughts to adopt the water restriction measures in each agricultural area.

Conclusion

Natural and environmental resources degradation in France do not have the same consequences as in arid countries, however the situation is of concern in particular because of the increasing number and intensity of problems. This degradation is all the more worrying in that the effects of climate change are increasing and will continue to do so. Agriculture is both victim and responsible for the situation. By employing the best agricultural practices, some problems could be resolved. Public measures such as the CAD and assessments of risk and need are also important to develop a sustainable agriculture.

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