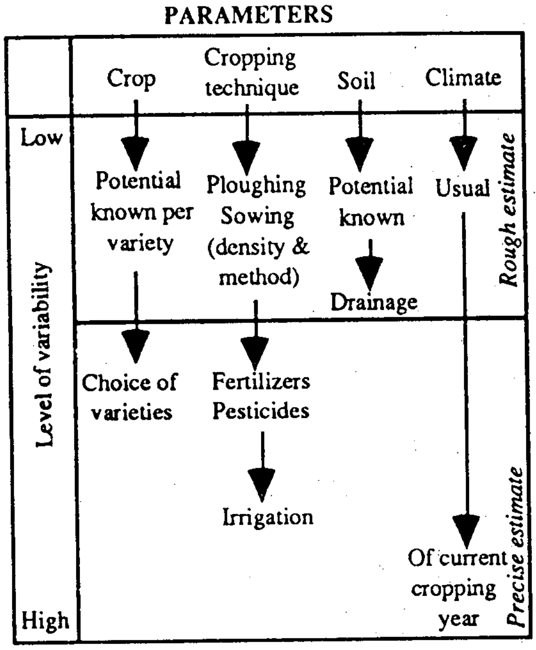
From crop production assessment on the basis of acreage measurements (EEC method) to quantification on a national level

ALAIN KILLMAYER

Abstract. Although the different data characterizing an administrative zone such as a province or a district comes from different satellites, it enables crop production to be assessed by the association of high spatial resolution (SPOT, Landsat TM), which provides crop acreage measurements, and temporal resolution (NOAA), which enables a trend to be established in relation to the archive reference.

The yield obtained from annual crops is in direct relation to the species, the cropping techniques used (variety, means of irrigation, fertilizers), the soil and the climate. All these parameters can vary enormously from one territory to another and therefore the ways in which farmers can counteract variations is very limited.

Figure 1: The variability of the different parameters affecting yield



The soil and the climate dictate to the farmer the species, varieties and cropping techniques to be used. Yield variability in relation to these parameters is thus very low and it evolves very little from one year to the next. Once these few elements are known, it is possible to make a rough estimate of the yield.

The farmer has the strongest influence on his future yield during the cropping season. Fertilizers, pesticides and irrigation are all deciding factors. But it is the year's climate that gives the finishing touch to the crop yield at special periods in the crop calendar, as it is the factor which has the highest rate of variability, and it is this element we propose to characterize.

The integrated system designed by GEOSYS is founded on a parameter information base and the monitoring of elements varying these parameters, especially climatic elements, during the cropping year. The principle of assessment is based on the estimation of vegetation status.

The system operates as a dynamic GIS (Geographic Information System), which means that the different levels of information are up-dated on a permanent basis as often as required.

Figure 2: The Geographic Information System

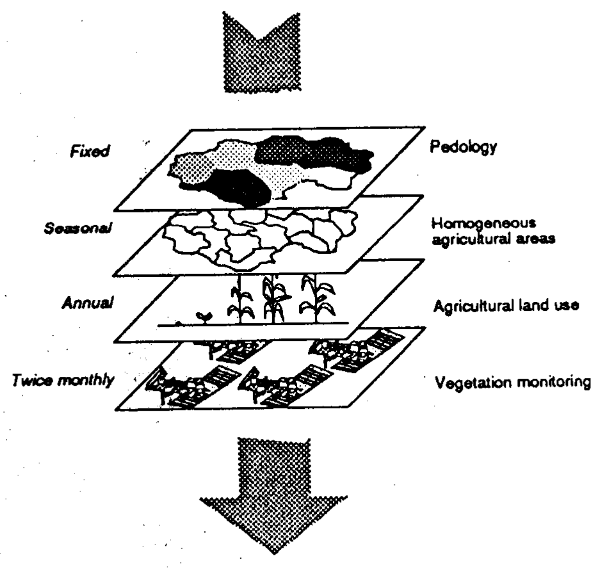
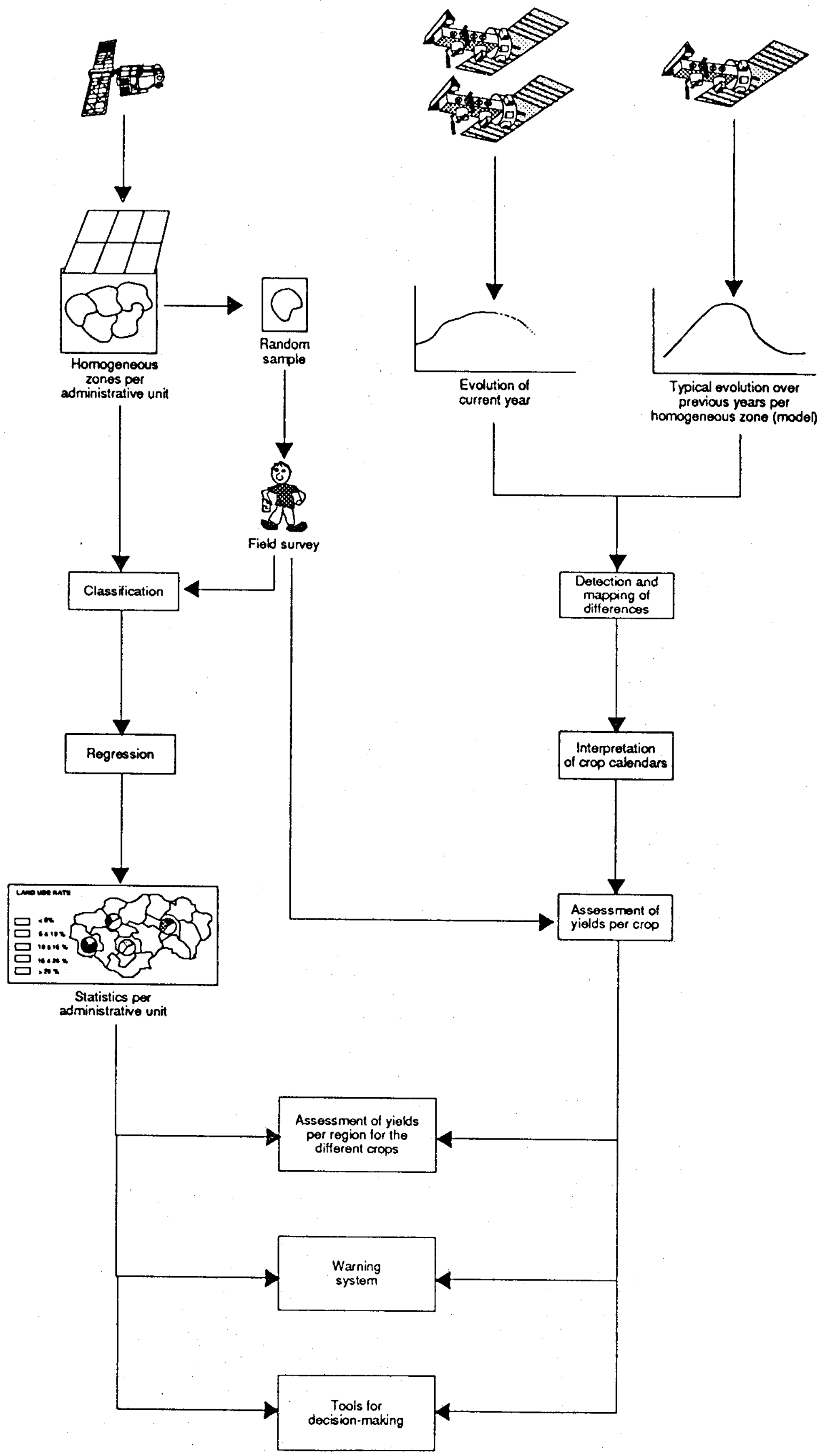


Figure 3: Methodological principle of the system

Figure 3 is shown on the following page.

Author: Alain Killmayer



Annual data base of land use

The method used was perfected with the European Commission's Joint Research Centre (JRC) in Ispra, Italy. The method is based on one-off field visits of homogenous zones and the information thus obtained is then generalized to the whole of the territory using high definition satellite coverage.

The date or dates of the satellite coverage are chosen in relation to the crops to be identified. A single image coverage is usually sufficient for identifying the main crops in the same cropping cycle (Summer or Winter).

This method has the advantage of reducing ground truth which can only represent at most 0.5 % of the territory. The survey segments are placed at random and are of a standard size. They are used for image classification and error study training and also enable regressions and the calculation of precision.

(For a country the size of Egypt, covered by 72 SPOT scenes, 480 field surveys are sufficient to provide classifications for each province with an imprecision rate per crop of approximately 15 %.)

The estimation of acreage for each crop is therefore sufficient for calculating yield forecasts for which the vegetation monitoring will provide the year's trend.

Assessment of climatic parameters during the year by vegetation monitoring

As the climatic parameters that affect crops are extremely difficult to model as far as yield is concerned, it would seem more appropriate to study the effects of these parameters rather than their cause.

If the state of vegetation can be measured in a destructive way, there is a close correlation with a radiometric indicator: the vegetation index. This index can be measured either on the ground by radiometry or at a distance. NOAA satellite data (channels C1: red and C2: near infra-red) provides measurements that are global (on a scale of 1 square kilometer) and present the advantage of being very frequent.

This frequency is used for modelling typical evolution which, when confronted with yield, enables a reference base to be established. The study of the differences between the normal evolution model and the current year enables effects of stress influencing yield to be detected. The differences in evolution compared to what has been defined as normal are then interpreted through agricultural land use, and the crop calendars that determine the stages of stress impact are recorded. One-off field surveys are necessary to quantify the different stress phenomena.

Conclusion

The GIS is thus supplied with levels of information that vary very little, and others containing the acreage of the different crops grown during the year, as well as frequent monitoring of the vegetation evolution, and in this way it enables crop production to be quantified.

Figure 4 is shown on the following page and is an example of a crop production map for one crop in a French administrative department for which the spatial precision used is the commune (smallest French territorial division).

Since 1990, GEOSYS has produced 700 maps over France and Spain for their respective Agricultural Ministries.

Author: Alain Kilimayer

Map of crop production variability