LAND EVALUATION

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Summary

In this paper a historical overview is given on how land evaluation in the past 50-60 years has developed from a subjective, viz. anecdotal appraisal to a well structured, systematic assessment of the land potential based on a strict methodological approach and interpretation of major land attributes. The focus in this paper is on land evaluation for agricultural purposes.

Land evaluation is the process of assessing the performance of land when used for a given purpose. Land evaluation may be operated either for a specific kind of use (maize,

potatoes) or for a more general utilization (agriculture, grazing) and is then referred to as land suitability or land capability evaluation respectively. Land evaluation may be qualitative or quantitative.

Land evaluation has initially emerged from soil survey interpretations, but since the 1970s it has become more plant-specific. This means that gradually more care is taken for crop-growth and production factors, including climatic, soil and management aspects. Two major approaches can be differentiated: parametric systems based on a numerical correlation between crop performance and key land attributes, and categoric systems which classify the land into units with different use potentials according to the number and extent of physical limitations to crop growth. The newest trends in land evaluation are discussed, including the increased use of crop simulation models as a tool for a more quantified assessment.

The principles of the different systems and their advantages and disadvantages are critically reviewed. Details on the application of the most representative systems are discussed in the individual contributions under this topic.

1. Introduction

Land evaluation assesses the performance of land based on a more or less systematic analysis of the physical land conditions and on the impact these have on present and alternative land use systems. Land evaluation is a tool or a technique to compare the various use potentials and benefits that can be obtained from the land, taking into consideration the current and expected social and economic contexts. Land evaluation in its simplest form selects the best land for a specific purpose and answers questions like:

- What are the properties of the land and which type of use offers the best sustainable production and/or benefits?
- What is the present land use and what alternative uses are physically possible and socially and economically relevant?
- What will happen if present practices remain unchanged? And how can the present practices be improved?
- What inputs are needed to achieve the desired sustainable production and minimize the adverse effects and risks?
- What are the adverse physical, economical or social effects and risks and what are the benefits of a given land use system or practice?

The evaluation process does not in itself determine the land use or land use changes, but provides data on the basis of which land use decisions and options can be taken. In other words, land evaluation helps individual land owners, regional development agencies or countries to make rational choices between land use alternatives.

2. Land Appraisal in a Historical Context

People make decisions on land and land use since the time - some 10,000- 12,000 years ago - that our civilization changed from hunters and hazardous fruit pickers towards a

more sedentary lifestyle. This transition period that is often referred to as the *Neolithic Revolution*, started on the Iranian Plateau and hilly regions of Northern China, and around a second nucleus in Central America. It spread to Europe through the Mediterranean Basin some 4000 years BP. The earliest settlers selected the best soils to grow crops and to satisfy their food and housing demands. Houses were built on the higher places out of reach of floods, and farmers planted the wheat, cassava and beans on the well-drained upland soils, while they reserved the wetter areas for rice cropping. Many tribal wars and conflicts, in the past and at present, find still their origin in the competition for land.

The "Book of Nabatean Agriculture" is one of the first known documents about rational land assessment and agriculture. It describes land properties and agricultural practices in Egypt and the Middle East long before our era. Reference to this work and to that of many other Persian, Greek and Latin authors was made by Ibn-Al-Awan, an Andalusian writer living in the 10th century AD in Sevilla, Spain, whose exceptional book *Kitab Al-Felahah* has been re-edited by Clément-Mullet in 1977 under the title "Le Livre de l'Agriculture".

Archaeological research reported by Evenari and co-workers (1971) has shown that around 2000-2500 BC the ancient cities of Shivta and Avdat in the Negev Desert were well-known stops on the caravan route between Egypt, the Persian Gulf and the Red Sea, and that the importance of these centers for food and water supply to the travelers resulted mainly of their sophisticated cropping system based on land appraisal and related good land management practices, including runoff agriculture and dew collection, in a harsh desert environment.

For a long time land and land-related issues were directly related to agricultural or livestock production, and assessment of the quality of land or practices to improve such qualities remained a matter of local rural expertise. Land was considered a natural free gift available to all members of the clan. As long as the population was small in number, the competition for land remained relatively small; exceptions to this natural rule occurred only in cases where a local group wanted to expand power and went to war with its neighbors.

This situation changed rapidly from the moment world population increased and the cities started to develop - corresponding to the early Middle Ages in Europe. At this moment people were no more personally responsible for their food production, and job diversification took place. Goods were exchanged in between individuals and between cities and the countryside: food and timber towards the urban centers, waste products (manure) and manufactured goods towards the rural areas.

With more people looking for land this attribute started also to acquire value, and a complete legislation had to be developed to avoid land conflicts. Land property rights had to be installed - leading initially to the establishment of national cadastral services - and, in a second stage, land became an object of taxation. Simultaneously, this created a growing need for a better knowledge of the soils and of their production potential.

Over time, knowledge on land has tremendously increased and so has the assessment of

the land, first as an inherent part of soil survey and soil survey interpretations and later as a more independent discipline (see *Soil Survey as a Basis for Land Evaluation*). In this respect land evaluation as a methodology and discipline has gradually moved from a simple soil survey interpretation to a more independent approach focusing in the first place on land use (including non-agricultural uses) and thus taking into consideration also other than only soil factors. The latter include climate and any other physical parameters which affect the yield of crops, as well as social and economic factors which determine benefits and profitability of the use of the land.

3. The Need for Land Evaluation

The amount of cultivable land in the world is finite, and land that has been degraded is almost irreversibly lost for production. As long as the populations who use this land remain small in number, they are able to live in harmony with their natural environment.
In the past 500 years the world's population has, however, increased from an estimated 427 million in the year 1500 to 1650 million in 1900 and more than 6000 in 2000. Recent projections point to a figure of around 10 million people by the year 2050. Accordingly, the average per capita available land has been reduced from 0.50 ha in 1950 to 0.25 ha nowadays. In some East-Asian countries it is 0.15 ha or even below.

The pressing demand for food and space from a growing population has created a competition for land. The best suitable land is already short in supply and even less suitable, viz. marginal areas, are gradually taken into cultivation. In many developing countries fuel-wood, cash crops, timber for construction and grazing for livestock compete with food crops for space, not only on the better quality land but also on the marginal areas. Coupled with inadequate land use practices this leads to a creeping soil degradation through loss of plant nutrients and organic matter, erosion, build-up of salinity and damage to soil structure. In the industrialized world the demand for more food has lead to an intensification of agriculture, and a high use of agro-chemicals. In the long run this situation has resulted in the pollution of soils and ground waters and, subsequently, in a growing concern about the protection of the environment.

The need for more arable land and the risk for land degradation in developing countries, and the growing concern for a protection of the environment in industrialized countries, including the set-aside of agricultural land, urge for a complete re-arrangement of space and for a more rational use of the available land. This can only be achieved if the properties of this land are known, a proper inventory of the natural resources is made, and a correct assessment of the relative suitability for different uses is operated. In this situation land evaluation provides a key technique to present and different scenarios and select adequate options for decision-making. Such decisions about land use need to be made at national, provincial, or district levels, and at the plot, or farm level. The basic process is the same, but the level of detail and map scale are different.

At present, the importance of land evaluation, and ultimately of land use planning, should be seen in the context of land becoming a scarce and non-renewable natural resource which is highly desired, for which there is a growing competition and which, obviously, holds a proper exchange value. It is moreover linked to a situation whereby

decisions to change the use of land may have a large influence on social attitudes and on the society as a whole. Agriculture for example is often viewed as an environmental problem, but if carefully managed, it can also become an integral part of the environment. If good quality indicators are available to monitor the impact of agriculture - or of any other land use activity - then decisions to change might be evident. This situation is developed in more detail in *Land Quality Indicators (LQI) : Monitoring and Evaluation.*

On the basis of the above it becomes clear that decision making about land use is a political activity with major social, economic and environmental impacts. This rise in public concern with planning issues involves that objective and scientifically-sound land evaluation techniques need to be developed for the identification of various alternative land uses.

4. Land Evaluation Terminology

There is considerable confusion over the terminology used in land evaluation. For a long period land evaluation was considered an inherent part of soil survey and classification. The term *land evaluation* was introduced for the first time in 1950 at the International Congress of Soil Science in Amsterdam and was then adopted by Christian and Stewart in Australia, who developed the land system approach as a workable means of classifying the landforms, soils and vegetation of a specified area together into one coherent pattern. This approach sits easily with medium scale land evaluation of areas such as districts and regions of countries, whereby it associates land resources with land use and, subsequently, creates the matching pair for land evaluation. Still for many years the connotations of soil survey interpretation, land classification and land evaluation were intermixed, and neither proper terminology nor working methodology existed.

It is only since the 1960s that attempts were made for a clear definition in terminology. In 1963 Vink still used the term *land classification*, which at that time was defined as "those groupings of soils that are made from the point of the people that are using the soils in a practical sense". This involved in principle as well the pedogenetic classifications as the land-use-oriented groupings of soils. The first attempts to distinguish also between those aspects came from Kellogg who, in 1962 wrote "it is highly important to distinguish clearly between soil survey interpretations and land classification". In 1968 Stewart qualified land evaluation "as the assessment of the suitability of land for a man's use in agriculture, forestry, engineering, hydrology, regional planning, recreation, etc". Land evaluation in the modern sense includes parts of these, but extends beyond all of them.

The publication of the Framework for Land Evaluation (FAO, 1976) constituted a turning point in conceptual thinking, whereby the (narrow) concept of *soil* was dissociated from the (much broader) concept of *land*, which embraces all aspects of land use and the human activities related to that use. At this moment a clear difference was also made between *land suitability* and *capability*, and land evaluation became a technique and a tool for land use planning.

Capability and suitability have often been confused or even regarded as synonymous. Suitability refers to a single, clearly defined, reasonably homogeneous purpose, practice or crop (with specific crop growth requirements); and suitability assessment has a sharp focus looking for sites possessing the positive conditions to apply the practice or grow the crop beneficially. Capability stands for a much broader use such as agriculture, grazing or urban development, and capability assessment must be vaguer; it is often defined in terms of negative limitations which hinder or prevent some or all of the activities concerned.

In this context a clear differentiation in terminology should be made between the connotations of land evaluation which is a general term, and land capability, land suitability and land value which are more specific terms. The terms of land appraisal and land assessment can be considered as common-language connotations with no specific technical meaning.

Land evaluation can be defined in general terms as the assessment of land performance when used for a specific purpose. Land may be evaluated directly, e.g. through the collection and processing of crop-yield data, or indirectly. In the latter case it is assumed that a number of diagnostic criteria influence land performance in a reasonably predictable manner, and that this performance can be deducted from the observation of those properties. In this context, land evaluation involves the execution and interpretation of surveys and studies of landforms, soils, vegetation, climate and other aspects of land in order to identify and make comparisons of promising kinds of land use in terms applicable to the objectives of the evaluation. The values allocated to those properties can then be integrated into either a categoric or a parametric system.

Land capability classification is a more specific term introduced by the USDA approach to land evaluation. It is used for a ranked system based on the severity of land limitations for general agricultural use and refers in particular to the quality of the land to produce common cultivated crops and pasture without deterioration over a long time. Good examples of land capability classifications are discussed in *Other Land Evaluation Systems*.

Land suitability classification relates to specific uses. In other words, it refers to the fitness of the land for a specific kind of land use, whether it be agricultural or non-agricultural uses. In the case of agricultural use the land use type may differ in terms of crops and/or management systems. The most representative example of such a classification, e.g. the FAO Framework for Land Evaluation, is described *in extenso* in *The FAO Guidelines for Land Evaluation*.

Land value involves a monetary or similar basis that can be expressed in annual rental value or in a capital payment. The corresponding term of **land valuation** is mainly used in German literature and refers to the assessment of the taxation value and a basis for the distribution of grants and loans to agriculture as defined by the 1934 legislation in the country. This topic is discussed in full detail in *The Value and Price of Land*.

A variety of other terms can also be found in the literature, but most often they can closely be related to the definitions above. These include connotations like: *soil*

capability classification (Canadian Land Inventory), *soil suitability classification* (Ireland), and *land use capability classification* (in the UK). *Land use classification* is a matter of the present actual use to which the land is put and not necessarily a reflection of the land's potential and limitations. *Terrain evaluation* is a broader, more geographical term, covering analysis of all aspects of land with regard to its natural features.

Land evaluation may be qualitative or quantitative. Unfortunately these terms do not always have the same meaning for different people. In the *FAO Framework for Land Evaluation* a qualitative assessment distinguishes from a quantitative one because it is based on physical land properties with only some sparse economic information at hand (the economic, social and environmental inputs representing then the quantitative factor). Over time, the connotation of quantitative assessment has more and more been applied from the moment the (qualitative) suitability or capability classes were correlated with yield figures. In practice, real quantitative land evaluation can only be achieved for studies at detailed or semi-detailed levels, and with a lot of information available. This topic is discussed *in extenso* in *Qualitative and Quantitative Land Evaluations.*

Land evaluation in itself is scale-independent, but the accuracy by which the land is assessed depends on the nature and details of available data. Hence, placed in a historic perspective the progress in land evaluation follows a remarkable trend which is closely in line with the increasing knowledge on land and crop sciences.

5. Changing Concepts in the Assessment of Land

Land evaluation has historically emerged from soil survey investigations and, therefore, assessment procedures were mainly focused on soil parameters (*Soil Survey as a Basis for Land Evaluation*). Gradually, it became obvious that amongst the physical factors, climatic parameters had an almost as important impact on crop growth and production, while also the role of mankind had to be taken into consideration. Since the introduction of the FAO *Framework for Land Evaluation* in 1976 a growing attention has therefore also been paid to both climatic growth conditions and the role of socio-economic factors in land issues.

Over time the assessment of the land use potential has passed through four major conceptual stages:

- a subjective and mainly anecdotic assessment of a limited number of well-chosen key soil properties, often based on local trials and personal experience of the evaluator;
- a tendency towards a translation of yield performances in simple mathematical equations, based mostly on a single-factor correlation between yield output and a few (mainly) soils criteria, leading ultimately to fully elaborated parametric systems;
- land capability assessment and soil survey interpretation;
- land suitability evaluations for specific crops and cropping systems based on soils and agro-climatic crop growth requirements, and taking into account socio-

economic and environmental aspects of land use.

The modern trends are towards an integrated and demand-driven approach marked by an increasing role allocated to non-soil factors, and providing a basis for land use planning. The end product of land evaluation is anyhow a document that should provide a technical basis for decision-making on optimal land use, whether private or public.

Although these different trends follow a certain time sequence in terms of conceptual thinking, it is not always possible to link them to a specific time period. After an initial subjective soil survey interpretation approach which dominated the trends until the late 1940s, the major tendency in land evaluation since the mid 1960s has been a shift from broad to specific assessments, increasing use of non-soil factors, and a growing demand for more quantified information. This has led to a diversity of approaches, ranging from straight-forward soil survey interpretations - and occasional climatic interpretations - to more sophisticated multidisciplinary integrated regional studies and to the application of simulation techniques. *The FAO Guidelines for Land Evaluation, Other Land Evaluation Systems* and *Agro-Climate-Based Land Evaluation Systems* give more details on the different approaches.

In this evolution conventional and modern procedures are employed side by side, depending on purpose, scale, and detail of the study and the specific background of the evaluator. Many of the currently applied conventional procedures are based on methodologies of many years ago but, when proven adequate, continue to be employed. In other words, when a new more quantitative land evaluation procedure was developed, the previous empirical approach may still be used for a first global approximation, while the more recent and more detailed procedure is reserved for further refinements, when also more detailed information becomes available.

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Biographical Sketch

Willy Verheye is an Emeritus Research Director at the National Science Foundation, Flanders, and a former Professor in the Geography Department, University of Ghent, Belgium. He holds an M.Sc. in Physical Geography (1961), a Ph.D. in soil science (1970) and a Post-Doctoral Degree in soil science and land use planning (1980).

He has been active for more than thirty-five years, both in the academic world, as a professor/ research

director in soil science, land evaluation, and land use planning, and as a technical and scientific advisor for rural development projects, especially in developing countries. His research has mainly focused on the field characterization of soils and soil potentials, and on the integration of socio-economic and environmental aspects in rural land use planning. He was a technical and scientific advisor in more than 100 development projects for international (UNDP, FAO, World Bank, African and Asian Development Banks, etc.) and national agencies, as well as for development companies and NGOs active in inter-tropical regions.