Adaptation of irrigation in farm forestry

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This talk summarizes some important hydrological aspects of irrigation. For the demonstration the program CropwWat 8.0 (FAO) has been used. Climatic data were derived using the program ClimWat (FAO).

Motivation

Why is it important to know basic principles of modern irrigation? A recent paper on Science Daily summarizes the imminent relevance of reconciling an increase in food production (often expected from better and more irrigation) on a global scale and the reduction of excessive water demands (often caused by irrigation): Irrigation, climate change, farm management and food production are put into a global context on resource optimization (Science Daily, October 2009. A solution for this dilemma can only be based on a sound understanding an integration of plant physiology, soil science, hydrological principles and socio-economic reasoning within a framework of sustainable development. Innovative approaches (e.g. agro-forest-farming) may offer ways to better management practices.

Scope

The scope of this short introductory lecture is to outline the principles of irrigation in agroforest-farming. Principles include the methodology for determining irrigation demand and timing including the FAO Penman-Monteith reference irrigation, as well as the concept of the crop coefficient K_c.

Online Material (preparation material for the lecture)

The Global Map of Irrigation at the FAO Aquastat Site gives a first reference and general information on the global distribution and relevance of irrigation. General information on soil, water properties related to irrigation is given by Scherer (1996). The basis for irrigation scheduling and intensity is still based on the calculation of potential evaporation and on related crop water requirements as calculated by the FAO. While irrigation has been and is a very efficient means of boosting productivity in semi-arid and arid regions or in climates with temporal deficits, irrigation is also by far the major process of water use. An emerging water crisis, beginning in the late 1960ies (Cyprus, Israel), limits water supplies for other processes. Therefore, there is an imminent need to optimize water use for irrigation (see Wolff & Stein (1999)). Since the 1990ies the focus is moving from optimal irrigation to deficit irrigation, the emphasis is on saving water without loosing productivity according to the Pareto principle: A series of articles on deficit irrigation can be found at the FAO site as an online publication on deficit irrigation. Deficit irrigation scheduling describes what irrigation is all about in terms of hydrology and plant physiology. An example, on how this looks like is given for the case of scheduling for optimizing potato growth. A recent issue, relevant for local irrigation schemes and for the global water balance is the impact of CO_2 on water use efficiency of plants. Isotopes provide an efficient methodology of studying and tracking water use efficiency (see abstract on the relationship between water use efficiency and isotopes.

Bascis

Water Balances and Salinity

Irrigation demand is about water demand of plants, productivity of biomass per m³ water used. The context of water use efficiency compared to other and often competing uses has become increasingly important. Methods for water balance updating and calculation are needed to optimize water demand. Salinity is a major parameter if irrigation practices and their medium to long term impact on soils is considered: indicators, principles of avoiding salinization and the hydrological background of salinization are introduced.

Indicators for Adaptation and Sustainable Improvement

Finally, indicators for developing modern but practical, sustainable irrigation schemes that integrate into the econmic framework are outlined.

References

Achtnich, W. (1980): Bewässerungslandbau: Agrotechnische Grundlagen der Bewässerungswirtschaft. Verlag Eugen Ulmer, Stuttgart, 1980, 621 pp., 292 tabs., 390 figs. (69 maps).