Introduction

Rice, the staple food in most of monsoon Asia, is a versatile plant, with a large number of varieties adapted to specific geographical and soil conditions. Some varieties grow as a dryland crop, many others as a swamp land crop in inundated fields, while some varieties are adapted to high-rising floodwaters and are known as deepwater rice or floating rice. Water is a critical factor in rice cultivation. A regular flow of water is required to nurture the plant to the flowering and ripening stages. The water level needs to be sufficient to create soil conditions in which bacteria produce the nitrogen needed for plant growth, and the water needs to be flowing in order to remove toxic materials. Keeping the plants inundated has a further benefit for farmers, as it suppresses weed growth, a perennial problem in the tropics. If the fields are watered from a surface source, the water flow also brings nutrients. Although monsoon Asia is known for its torrential rains, rainfall is highly unequally distributed in the region; there are areas receiving only small amounts of rain, and experiencing six or more dry months. In these areas irrigation is crucial for rice cultivation. Whether irrigation is possible depends on the local geographical conditions.

In the course of time a wide variety of irrigation structures have been built in Southeast Asia, ranging from small-scale systems with simple weirs and off-take canals, to large-scale canal systems branching off into many smaller canals. Irrigation associations managing these systems equally show a variation. The distribution of different types of waterworks and accompanying institutions in Southeast Asia is not random. A closer inspection of irrigation structures in comparative perspective, shows that geographical variables, such as climatic and geomorphological or topographical conditions, play an important role in their distribution.
Climatic conditions to a large extent determine the irrigation requirement. The amount of water needed to raise a crop depends on water availability, which is the result of local rainfall ($P$) minus potential evapotranspiration (PET), that is, the water that potentially evaporates from the leaves of the plant and from the soil. Depending on the result of this equation, the irrigation requirement can be large or small.

Topography of the area influences the scale of irrigation systems and the possibility of creating storage reservoirs. In mountainous areas local communities can establish small-scale irrigation systems. In larger floodplains, larger management systems are needed. In river deltas, with an abundance of water during the wet season, and drought during the dry season, technologically more complex irrigation systems are required.

These two factors are broad constraints, setting the framework for specific irrigation structures. Although temperature is in principle a limiting factor as well, I will not take it into consideration, as I will limit my discussion to areas lying within the tropics (minimum temperature of the coldest month 18 degrees Celsius).

Wittfogel formulated his much criticized theory of hydraulic society on the basis of rainfall patterns. He distinguishes three basic levels of water management, each fitting a specific pattern of rainfall, namely, 1. rain-fed agriculture, where cultivation is dependent on natural precipitation, to be found in areas with abundant rainfall; 2. hydro-agriculture, where cultivation is based on small-scale irrigation or local community-based water management, prevalent in areas with both a wet and a dry season; 3. hydraulic agriculture, characterized by the development of large-scale irrigation works, managed centrally by a bureaucracy, found in arid regions (Wittfogel 1931:188-291, 1957:18, 23).

Wittfogel’s theory is based on a causal sequence, theorizing that the development of large-scale irrigation works led to the development of a large bureaucracy, which formed the foundation of a managerial state, with its particular Asian variety of ‘oriental despotism’. Wittfogel argues that the construction and maintenance of large-scale waterworks required the deployment of a massive labour force, which could only be mobilized by an authoritarian and centralized state.

Critics of his theory have mustered empirical case studies to argue that state centralization is not a necessary concomitant of large-scale irrigation works. However, critics have often disregarded the fact that Wittfogel has consistently maintained that the classic ‘hydraulic state’ was to be found in arid regions (Hunt and Hunt 1976:390). The argument that in certain regions irrigation was not large-scale and the state was not centralized, is not a valid counter-argument, if that region had sufficient rainfall for hydro-agriculture.

A methodological problem of Wittfogel’s hypothesis is, as several anthropologists have pointed out, that the issue of state centralization is ambiguous