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REVIEW

Rural Hydrology: An Alternative Approach to Rural Infrastructure Build-Up in Bangladesh Rural Development

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Abstract

The authors propose a "rural hydrology" approach for investigating and planning of rural infrastructure build-up in the floodplain zone of Bangladesh. The rural hydrology approach, a form of "alternative engineering", requires the following minimal set of items; a motorcycle or bicycle, feet to walk around, an eye to see the real environmental conditions, an ear to listen to those who are informed of the local conditions, and a flexible mind to share with local people, in order to identify land and water conditions, constraints to development, and the real needs of the locality and local people. Here, a case study is documented. The dynamic hydrological environment of the Tangail district floodplain was analyzed at the level of the *union* and the results were proposed to be applied to formulate plans for building rural infrastructures. Based on the rural hydrological viewpoint, it is possible to understand a correct dynamic hydrology of the *union* level. It should be possible to make plans for soil mounded feeder roads, culverts and bridges, which do not disturb the hydrological balance and stability of crop production, using only reasonable labor instead of a great deal of labor and investment. "Rural hydrology" can be a practical proposition for rural development in less developed countries.

Discipline: Agricultural engineering
Additional key words: dynamic hydrology, living with flood, floodplain, *union*, *bangha*

Introduction

One of the basic obstacles to rural development in Bangladesh is flooding which causes insufficient maintenance of rural infrastructure. "How to cope with floods?" has been an important subject for rural people living in the flood-prone area. Two ideas have been discussed for sustainable rural development at the national flood policy level. One of them is to "live with the flood" and another is to "control the flood", both ideas stand on opposite positions[3]. On the other hand, the authors could find out knowledge and technology of the villagers to coexist with floods at the local level through research in rural Bangladesh. This is the way to adapt to and utilize floods rather than control them[4].

The authors have implemented action programs in a village located in the Jamuna floodplain as a part of the "Joint Study on Rural Development Experiment (JSRDE)" project funded by the Japan International Cooperation Agency (JICA) from 1992 to 1995. In this paper, the authors are trying to clarify their tentative idea formed in the process of their trials for a way of planning infrastructure. It is asserted that understanding of the dynamic hydrological condition in rural areas for planning of local infrastructure, especially soil mounded

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roads, namely, feeder roads is of importance, and the viewpoint and methodology of "rural hydrology" is proposed to understand the local dynamic hydrological condition. In rural hydrology, most information is collected from interviews with farmers. When the authors interviewed they tried to meet with many people, including men of influence, for as long a time as possible. Questionnaires and tape recorder were not used to avoid inviting farmers' suspicion.

"Rural hydrology" approach to the planning of local feeder roads

During the flooding season the *nouka* or boat is the traditional means of transportation in rural areas of Bangladesh. However, the need for land transportation on foot and by bicycle or *rickshaw* (tricycle for human transportation) even in the rainy season is increasing recently due to economic development and the interaction of villagers with towns. For land transportation in the rainy season non-flooded roads are used. Feeder road construction is one of the most important tasks for rural development in Bangladesh to positively support rural activities. Though feeder roads are made with soil, they also prevent free water movement. Without taking account of water flow, construction of feeder roads would destroy the equilibrium of the local dynamic hydrology. It may be said that road construction in Bangladesh has been done under a strategy that neglected the idea of local dynamic hydrology for more than one hundred years. However, in Bangladesh, feeder road construction supported by the idea of local dynamic hydrology is just what is required nowadays in the context of rural development which emphasizes sustainable rural development and to realize the "living with floods" concept.

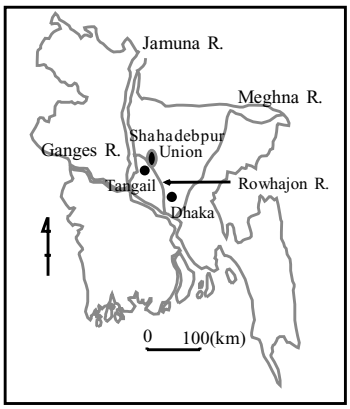
The authors researched an actual situation of feeder road construction as members of JSRDE. In the research they tried to grasp local dynamic hydrology using a methodology named "rural hydrology".

"Dynamic hydrological condition" of Dakshin Chamuria Village

1. Resource map of the *union* level

The target village Dakshin Chamuria (henceforth called D village) is located on the left-side of the Jamuna (Bhramaputra) River, some 65 km northwest from Dhaka, and belongs to Shahadedpur *union* (smallest administrative unit), Kalihati *thana* (county), Tangail district. The village is on the floodplain formed by a branch of the Jamuna called the Lowhajon River and the area has scattered *bil*s (marsh) and soil abounded with sand and loam.

To grasp the local dynamic hydrology a map showing the spatial location of rivers, *khal* (canals), *bil*, roads,



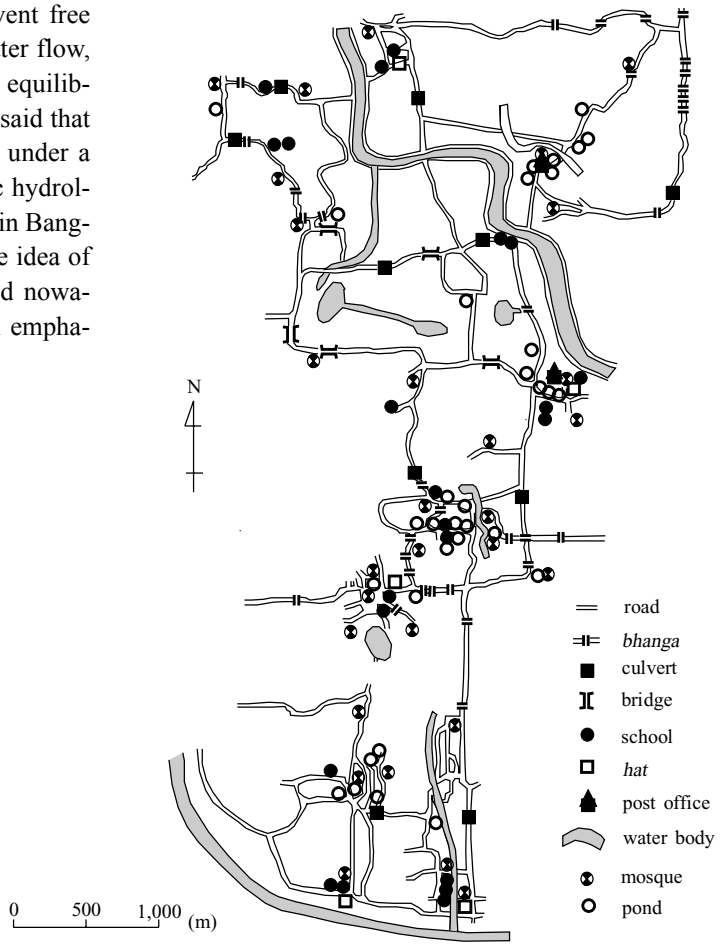


Fig. 1. Shahadebpur *union* resource map

bridges and culverts was needed at first. In Bangladesh maps showing the relative location of districts, *thana, union* and *mouza* (local unit for tax collecting) are available[2] but the *union* level maps, showing basic information of bazaars/*hat* (weekly bazaar), schools, public agencies, mosques, rivers and roads etc., for practical use are not yet published. Consequently, the authors have made a resource map of the *union* concerned, at first, by following-up with a survey using motorcycle based on the project members' previous survey using bicycle (Fig. 1). They used an odometer attached to the motorcycle and a compass for accuracy.

Usual access of villagers to public facilities of *hat*, school etc. and to the main road connecting with the city depends on soil mounded roads, namely, feeder roads. *Union parishad* (council) plans the construction of feeder roads and construction starts after getting permission of the *thana* council. Basic information from the above mentioned map would be very necessary for implementing a *union*-wide development plan.

Most people of Bangladesh including *union parishad* members are not accustomed to using maps, so that they rarely want to make maps. Only a very simple map could be made by the *union parishad* to attach to the proposal of the five-year plan for each facility. This kind of map can not show us the total *union*-wide rural infrastructure development plan correctly.

Union parishad is the only local authority which can request a development plan of infrastructure administratively as a representative of villagers. A resource map of this kind, which can be made without much labor and cost, must be put regularly in prominent places of the *union parishad* office in order that members think of infrastructure development frequently, and as a result impartial and sustainable development would be promoted.

2. "Dynamic hydrological condition" of D village

Resource maps of Shahadebpur *union*, in which D village is located, representing western Elenga *union* and northern Bangra *union* respectively, were made. Using these resource maps the watershed map showing the location of roads, water bodies and drainage facilities like culverts and water flows in the rainy season was made (Fig. 2). Villagers describe water conditions in the rainy season by the amount of rain and spilled water from rivers. A normal year is called *barsha* (normal inundation) and flooding conditions in a year with flood damage is

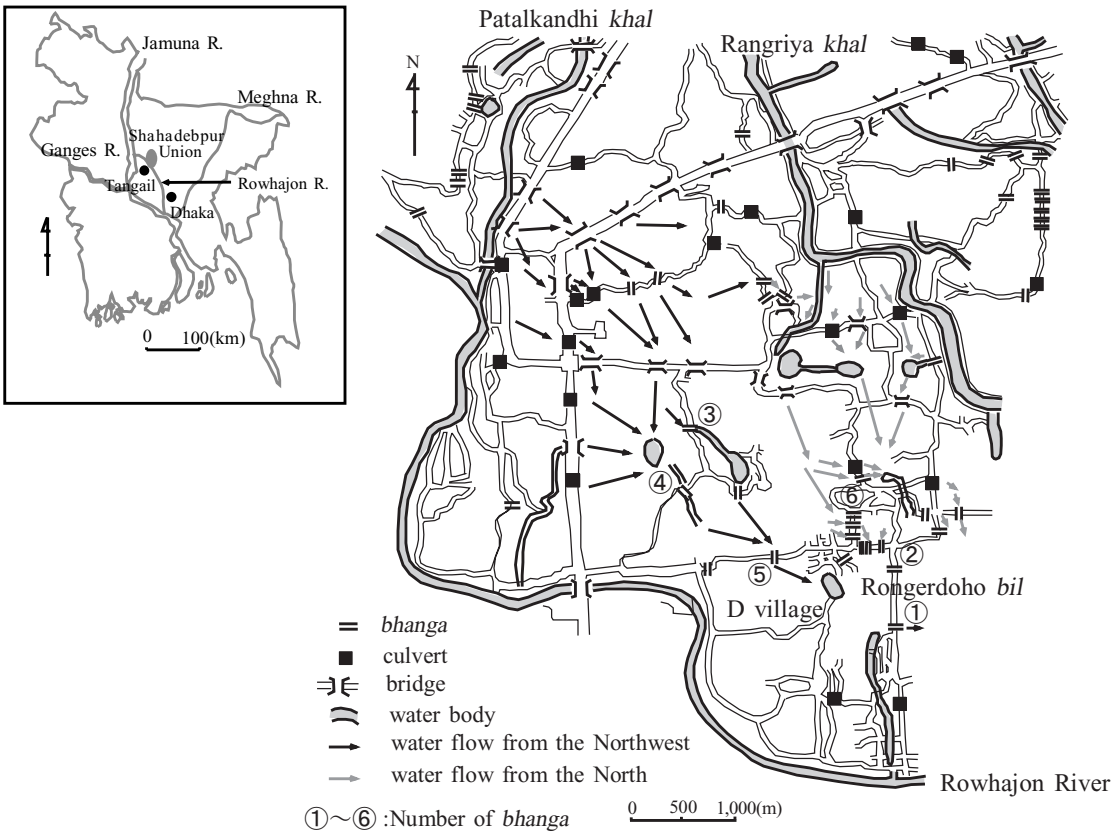


Fig. 2. Dynamic hydrological condition in Shahadebpur *union*

called *bannya* (disastrous flood). Fig. 2 shows the dynamic hydrological condition of *barsha*. Rapid water increase or decrease and high speed of water flow in the rainy season are hydrological characteristics of the dynamic hydrological condition of D village.

As shown in Fig. 2 there are two main water flows coming to the cultivated land of D village in the rainy season. The bigger one is coming from Patalkamdhi *khal* in the northwest area connecting with the Lowhajon River. This water flow crosses two bridges on the main paved roads and comes through some culverts, *khal*s and broken-down sections of road called *bhanga*s. Finally, this current flows out to the east of the village through Rongerdoho *bil* inside the village (water flow from the northwest). The water flow from Rangriya *khal* in the north also crosses roads after spilling over to drain and the *bil* is directly connected with the *khal* and comes to the village flowing out to the east of the village (water flows from the north).

The important fact is that the water flow spilled over *khal*s crosses not only facilities like culverts but also broken-down parts of road called *bhanga* before reaching the village. As shown in Fig. 2, there are a lot of *bhanga*s on the course of the water flow from the north. *Bhanga*s of various sizes are passable on foot without any help in the dry season and with bamboo bridges in the rainy season. However, *rickshaw*, cattle cart and other kinds of transporting vehicles sometimes cannot cross even in the dry season.

Bhanga could be rather an obstacle judging from the viewpoint of passing traffic. However, if there were no *bhanga*s in the places where they are located, water flows would become quite different from that shown in Fig. 2. So the existence of *bhanga*s can be said to be an important element which makes the dynamic hydrological condition surrounding D village. In fact, most of these *bhanga*s are needed for boat transportation and some of them are even made artificially for drainage by farmers themselves. We make clear the idea of farmers for dynamic hydrology through some case studies of artificial *bhangas* in the following section.

Dynamic hydrological condition and artificial *bhanga*s

Construction of local bridges and culverts in Bangladesh has been mainly supported financially by non-government organizations, namely CARE. It is required for CARE funds that projects smooth car traffic without *bhanga* and promote access to public facilities after bridge construction. Some *bhanga*s were made by big floods, some have been *khal* crossing roads from old days and some were made artificially for drainage. *Bhanga* no. 5, in Fig. 2, the length of which is some 15 m, located on the second main *union* road has been left for more than 20 years under the pressure of necessity. One of the *matabaar*s (men of influence in the village) of D village explained the circumstances below.

"There was not a *bhanga* here when *thana* office made soil mounded road of one and half *hat* (1 *hat* = 40 cm) width on the ridge in 1965. The *thana* road-enlarging project started in 1967 and at that time I became a representative of our village. We decided to make one *bhanga* for water pass on enlarged road. It was very difficult to decide where the *bhanga* would be, because neighboring land of *bhanga* should be compacted by construction of *bhanga* and ownership of land near *bhanga* would be also troublesome. The *union* chairmen of Shahadebpur and neighboring Elenga and *matabaar*s from near seven villages gathered to decide where *bhanga* should be located. Finally the place where it exists was decided unanimously to prevent crop damage and to drain quickly to Rongerdoho *bil*. At that time, we had *union parishad* made to lay out for bamboo bridge for the rainy season and it fell into the habit. Our request for permanent concrete bridge on the *bhanga* was not yet accepted until today. It may be mentioned that the road was repaired in 1971 and 1982.

Water depth of this area was more or less same before road construction. After road construction, water depth in the north land is deeper than that in the south because water which was used to flow out from the east in former days concentrates to the *bhanga* and it becomes impossible to drain out through only one *bhanga*. The difference of such water depth is not inconvenient in *barsha* year but the yield of broadcast *aus/aman* (rice variety in the rainy season), both not cultivated today, decreased to two thirds after road construction."

Farmers cut no. 6 *bhanga* the following year after road construction which ignored the farmers' proposal for drainage facilities in 1973. One of the farmers concerned explained the situation below.

"The *union parishad* made soil mounded road of three to four *hats* thick on the ridge of paddy fields in 1973. We insisted the necessity of *bhanga* for draining water from eastern side to western side of the road. But the *union* level staff refused our proposition saying we could cut the road in the rainy season if we would need. In the western fields of *bhanga* there was hardly rice production because of much water in that year. In the next year, rice field owners gathered at my house and decided if our fields would be flooded deeply we would cut the road on right place to save rice. In *Ashar* (mid-June to mid-July) month we cut the road to drain out water when

flood occurred, so that water flowed out to eastern fields and there was no damage on rice (drained-out water further to the eastern side to flow into the Lowhajon). In 1978, when the *union parishad* requested to fill up the *bhanga* again we have neglected the proposal. In 1982, when the *union* repaired the road to provide traffic convenience we had permitted to bury the *bhanga* only four *hat*s but not all width. We had to cut the closed *bhanga* in 1988 again. We had no reply from the *union parishad* until today although we have offered several times to set a culvert on the *bhanga*. The *union* does not intend to set even bamboo bridge there in the rainy season. We are setting a bamboo bridge taking bamboos from our village annually for human traffic. A culvert should be set just on the *bhanga* for the purpose of protecting rice from flood and human traffic."

In the former case described here the dynamic hydrological condition could be maintained by organizing villagers, and villagers could have convinced the administrative officers about the necessity of *bhanga*. In the latter case the villagers could realize the maintenance of the dynamic hydrological condition being opposed by the administration. In that sense we must read the accumulated will of farmers intending to maintain the local dynamic hydrological condition historically in Fig. 2.

Many farmers of D and neighboring villages criticized severely the lack of knowledge of administrative officers on water flow. Really, in the above mentioned cases, there was no positive intention to consider farmers' request for bridges and culverts. This kind of administrative attitude invited many cases of embankment-cutting and road-cutting when floods occurred in Bangladesh. It is reported that more than 40% of embankments were cut by farmers in the 1987–1988 floods[1].

Farmers' knowledge of the local dynamic hydrology should be given due importance in setting *bhanga* even in road construction planning, and effort should be made for framing public and continuous planning after extensive study of the local area.

Conclusion

It is very rare that the dynamic hydrological condition is considered in the planning of road construction in *thana* and/or *union parishad*. It is because of a lack of such a viewpoint among officers and not because of a lack of budget for survey and/or culvert construction. Namely, administrative officers are apt to think that only technological means using survey and/or current survey instruments can clearly characterize the hydrological condition.

Technological methods depend on measurement of water depth, current etc. by instruments and, first of all, it basically has the idea of "water control". Flood, for farmers, has been a matter of living-with and adapting to more than controlling water as expressed by the term "live-with-flood". The history of farmers' adaptation to flood has made the dynamic hydrological condition which can be seen today. The dynamic hydrological condition could not have been formed without villages because it has been closely related to not only the natural environment but also human activities. Although measurement by instruments can reveal a part of the dynamic hydrology, the total image cannot be understood only by such means. Technological methods do not take account of human activities such as historical background and the will of farmers, which are important elements to understand the local dynamic hydrology.

It is possible to collect qualitative hydrological data covering a period of more than ten years and derive an empirical theory concerning dynamic hydrology by interviewing a large number of farmers. We can use the terminology of "engineering hydrology" for the technological approach and the terminology of "rural hydrology" for the interview approach. Based on the rural hydrological viewpoint, it is possible to understand a correct dynamic hydrology of the *union* level. It should be possible to make plans for feeder roads, culverts and bridges, which do not disturb the hydrological balance and stability of crop production, using only reasonable labor instead of a great deal of labor and investment. In this way, "rural hydrology" can be a practical proposition for rural development in less developed countries.

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