MISCELLANEA GEOGRAPHICA
WARSZAWA 2000 Vol. 9

Izabella Łęcka

WATER ENGINEERING PROJECTS AND THE SPREAD OF PARASITIC INFECTIONS IN TROPICAL AREAS OF AFRICA AND ASIA

INTRODUCTION

The numerous, frequently quite opposite opinions, which exist in the literature, concerning the influence of water engineering projects on natural environment and on man, motivate to paying a deeper attention to changes appearing in the zone of such influence. Both the supporters and the opponents of such investment projects use in respective discussions different data, and refer to different cases, allowing them to justify their opposing opinions. In this situation it is interesting to carry out an in-depth analysis of the most controversial side effect of construction of the water engineering structures, namely — of their influence on the development of vector borne diseases of man linked with aquatic environment. Analysis was carried out on the instance of projects implemented in Africa and Asia. The choice of these two continents was by no means incidental. The highest indicator values in the world are observed there in terms of occurrence of the so called tropical diseases, and the water engineering projects which are implemented there serve multiple purposes, such as flood control, water storage in man made lakes, ensuring its constant supply, even in dry months and years, development of irrigated agriculture, facilitated navigation, as well as recreation and hydropower generation.

DISEASES ACCOMPANYING THE WATER ENGINEERING PROJECTS

Water engineering projects may exert a positive influence on the health of local population owing to, in particular, guaranteed availability of drinking water, or in an indirect manner, due to the development of health care following a general economic growth of the given area. Yet, the environmental and social changes linked with some kinds of water engineering projects may also have negative influence on human health. The diseases which appear then can be divided into two groups: the ones which can appear

already during construction of dams and irrigation channels, filling of the reservoir, etc., and those, which surface much later. Themselves resolve a part of problems, linked with the increase of disease occurrence in the initial period, as the construction work is terminated.

The second group of diseases connected with implementation of water engineering projects, those which appear in later period, includes such that are much more dangerous for human life, whose medication is more difficult, and conduct of preventive action oriented against their spread is more expensive. These diseases occur first of all among the population inhabiting a given area permanently, and most of all among children. As time goes on, an increasing proportion of local population usually contracts the disease. All of the diseases belonging to this group are linked with water resources.

The present report is devoted to the spread of schistosomiasis (the bladder variety — *Schistosomiasis haematobium*, and the intestine variety — S. *mansoni* and S. *japonicum*, appearing only in Asia), malaria, Bancroft's and Malayan filariasis, as well as onchocercosis ("river blindness"). Such a particular selection was motivated by the fact that these are the most common and dangerous of the parasitic infections appearing in tropical areas, and their spread exactly in the vicinity of water dams and reservoirs is often emphasized in the literature. Vectors of these diseases are linked with water, because they are amphibious (like snails — the intermediate hosts of the *Schistosoma* parasite) or they spend in water their larval stage of development (like mosquitoes, transmitting malaria and both filariasis considered, Bancroft's and Malayan, as well as a gnat *Simulium*, the intermediate host of the *Onchocerca volvulus* parasite).

A number of factors as consequences of realization large projects may appear which modify the course and the rate of occurrence of diseases.

RESULTS

The relation between the occurrence of parasitic diseases of man and the construction as well as functioning of water engineering structures has a very complex nature. The analysis conducted on the bases numerous reports and field works allowed drawing the conclusions:

1. The emergence of water engineering projects is most often conducive to the spread of these parasitic diseases of man, whose appearance is linked with water. Not always, though, this dependence takes place automatically, and numerous exceptions are observed.

Most frequently, after the artificial reservoir and the network of irrigation canals have been created, the spread of schistosomiasis takes place (like, for instance, on a significant area of Egypt, within the Gezira system in Sudan, and Kisumu in Kenya, in the vicinity of reservoirs of Bakoloria and Kainji in Nigeria, etc.), while the increase of morbidity related to malaria is observed somewhat less frequently. Although always, after termination of a

water engineering project, a change in the specie composition of mosquitoes is observed (toward those more effective in transmitting the malaria parasite *Plasmodium*), this does not necessarily lead to an increase in the percentage share of persons sick of ague (as it occurred, for instance, in the rice fields of the systems of IADP in Sierra Leone and Mayo-Danai in Cameroon).

It is hard to justify, for the two continents, the increase in the spread of filariasis (Bancroft's and Malayan) by the emergence of water engineering projects, primarily due to lack of adequate studies concerning this problem. Filariasis, though, seem to be easier to control. The actions oriented against malaria, undertaken both in Africa and in Asia, often succeed in eliminating effectively just the filariasis (as this occurred in the areas of artificial reservoirs of Kainji in Nigeria, Akosombo in Ghana, and Mahaweli on Sri Lanka).

The influence of water engineering projects on the spread of onchocercosis is always distinct in the vicinity of spillways on dams, where advantageous conditions for vectors arise and where the hazard of infection increases. On the other hand, though, formation of an artificial reservoir entails quite an opposite situation, since disadvantageous breeding conditions for the gnats *Simulium* arise, and the reach of occurrence of sickness either gets limited or the disease is entirely eliminated from the vicinity of the reservoir. Onchocercosis, occurring in definite foci, is relatively easily controlled outside of its endemic area in West Africa, owing to application of chemical actions of destruction of the breeding grounds of the vectors. The cases of onchocercosis have not been, on the other hand, noted in Asia until now at all.

2. The increased intensity of spreading of malaria and filariasis (Bancroft's and Malayan varieties) is observed within the areas of water engineering projects in South-East Asia (especially in Indonesia, Malaysia, Sri Lanka and India). The increase of sick rate regarding these diseases in the neighborhood of artificial water reservoirs in Africa is observed less frequently, in spite of the fact that they are common on numerous areas of this continent. Examples are known of land improvement systems in Gambia, Burkina Faso, Cameroon, Mauritania, and of the reservoirs of Akosombo on Volta river, Kariba on Zambezi, and Owen Falls on the Nile, where appearance of these structures has not resulted in an increase of morbidity among the local population. In some cases (like near to the reservoirs of Akosombo on Volta and Kariba on Zambezi) construction of water engineering projects could only insignificantly add to the percentage shares of the sick, since even before this indicator had been close to 100%.

Schistosomiasis and onchocercosis constitute the greatest threat in Africa, where they are endemic on a significant area. Bilharziasis (*S. japonicum*) occurs only locally in South-East Asia, in small foci, although in many regions the conditions for development of the parasite *Schistosoma japonicum* are perfect there. Most probably, this state of things is largely due to the decision of limiting construction in numerous Asian countries (e.g. in Indonesia, Philippines, Malaysia) of the large scale projects, especially those, where the surface area of the irrigation system would exceed 16 thousand hectares.

3. It is quite exceptional — in spite of the opinions often voiced in the literature — that the parasitic diseases here considered be introduced for the first time into the areas where they have not been noted before. The analysis of data available indicates that such cases appeared solely in the process of spread of schistosomiasis on the tropical areas of Africa. After the water engineering projects had been finished this disease appeared for the first time on the areas of the irrigation systems of Gezira and Khashm-el Girba in Sudan and within the areas surrounding the reservoirs of Diama in Senegal, Bakoloria in Nigeria, and Kariba in Zambia and Zimbabwe, as well as locally on the improved areas in Ethiopia. In case of the remaining parasitic diseases considered here there is in principle lack of data confirming the first introduction of these diseases into the areas affected by a water engineering project during its execution. The sole confirmed cases concern the renewed appearance of malaria on some areas, which had been thought already clean of the disease. Yet, the return of the ague, after years of break in transmission, occurs rather frequently, also on these territories, where no new water engineering projects have been implemented. The phenomenon of return of malaria has been observed on many territories of South and South-East Asia.

4. It was only in the case of malaria that we succeeded in demonstrating the relation between the spread of a disease and the type of climate within whose reach a given water engineering project is being realized. In case of other diseases no such regularities were uncovered.

5. The presence of vectors of parasitic diseases does not have to be necessarily linked with the spread of diseases. Cases are known of appearance of snails capable of transmitting schistosomiasis on the areas where this disease is not observed (like, for instance, the lower part of Awash valley in Ethiopia, and locally in Egypt). The examples also occur of the areas where mosquitoes are numerous (like close to the reservoirs of Owen Falls in Uganda and Ubolratana in Thailand, as well as in the rice fields in Burkina Faso and Cameroon), but they do not transmit neither malaria nor filariasis. Similarly, the reach of appearance of *Simulium* gnats is much bigger than the area of occurrence of onchocercosis.

6. It seems that realization of the large scale water engineering projects is connected with the risk of appearance of a number of parasitic diseases considered, as this was the case of Akosombo, Bakolori, Kariba, and High Aswan Dam. Construction of the smaller land improvement systems entails an increased hazard of spread of just one disease, for instance schistosomiasis in the region of Malumfashi (Nigeria) and in the district of Bandiagara (Mali).

7. The negative influence of the more recent water engineering projects (constructed starting with the second half of 1970s) is definitely smaller than in the case of the older ones. This is especially well seen in the process of spread of schistosomiasis and malaria (rice field in Sierra Leone, Burkina Faso, Cameroon and Mali). Such a situation, though, is not a rule. Appear-

ance of the Diama reservoir in Senegal and the Chao Nen reservoir in Thailand in the 1980s contributed in a clear manner to the increase of the number of cases of schistosomiasis (Diama) and ague (Chao Nen).

In case of filariasis it seems that the time of construction of a water engineering project has no essential significance. This disease has been spreading on the areas of both the new projects, like the irrigated fields of Solulor in Gambia, or the areas located in the vicinity of Bakoloria reservoir in Nigeria, and the quite old ones, like the irrigated fields in Egypt. Within the areas of projects terminated already some time ago the chemical actions of stemming morbidity, primarily with respect to malaria, gave an advantageous effect in terms of curbing the occurrence of Bancroft's filariasis (like in the regions of Kariba, Kainji and Akosombo).

8. The modifying influence of tradition and cultural habits is observed in cases of such diseases as schistosomiasis, malaria and the two filariasis (Bancroft's and Malayan). On the other hand, no such influence was noted with respect to the process of spread of onchocercosis.

Within the areas affected by the water engineering projects hygienic habits play a much lesser role in the spread of the parasitic diseases considered than it has been often supposed in the literature. First of all, though, hazards related to hygienic routines are relatively easily removed. In case of schistosomiasis and of the two kinds of filariasis (Bancroft's and Malayan) observation of the rule of hygiene, construction of modern latrines and elimination of the simple sinks are the necessary conditions for the complete eradication of these diseases from the areas of water engineering projects. With respect to schistosomiasis the hazard is constituted by the excrement and urine refuse, which can contain eggs of the *Schistosoma* parasite. In the process of spread of filariasis the waste spilling from the latrines is essential for the development of vectors, that is, mosquitoes of *Culex* genus, preferring waters polluted with organic substance. In both these cases construction of modern sanitary facilities and elimination of the old hygienic habits (or rather, lack of such habits) does not constitute, alas, the sufficient condition for a complete eradication of these diseases from the areas on which water engineering projects are realized This is confirmed by the examples from Sri Lanka, Zanzibar, the area of Kisumu in Kenya, the region of Bakoloria in Nigeria (in terms of the spread of filariasis), as well as the Gezira system in Sudan (with respect to transmission of schistosomiasis). Yet, it appear that in the villages of South and South-East Asia efforts are more frequent of replacing the usual sumps with some more advanced facilities.

A significant influence on the spread of parasitic diseases transmitted by the mosquitoes, that is — malaria and filariasis (Bancroft's and Malayan) is exerted by the nature and state of housing. In the regions, where houses are built of clay and palm leaves, and besides this technical condition is poor, i.e., there are no glasses in the windows, mud floors prevail, dust and dirt are a usual condition, the hazard of infection increases, because the disease vector may easily get in touch with humans. On the top of this, it is more

difficult to carry out chemical actions of elimination of mosquitoes under such circumstances. These observations concern equally Africa and Asia.

The traditional division of labor in the society exerts an influence on the spread of parasitic diseases over the areas affected by the water engineering projects solely in the cases of schistosomiasis and malaria. This influence has a similar nature on both continents considered. The most frequent cases of bilharziasis are observed among those who spent most of their time working in the field. With respect to malaria higher frequencies are observed among the population performing permanently certain activities (like, for instance, gathering of fuel) in the vicinity of breeding grounds of mosquitoes. Such a situation is observed particularly in these villages, where houses had been built at far distance from the breeding grounds of the disease vectors.

The traditional division of labor in the society does not exert a greater influence on transmission of filariasis, nor on the spread of onchocerciasis.

9. Migrations are an important factor modifying the dynamics of spread of schistosomiasis. This reflected through the examples of population movements in the regions of such African dams as High Aswan Dam and Kariba, the Gezira system, and also, as it can be supposed, on the areas of the Asian water engineering projects. The situation is similar in case of malaria (Kariba and Gezira, as well as examples from Libya, India and Nigeria). Population movements make it impossible to attain full success in eradication of the ague, even with application of chemical methods of control. In case of filariasis it can be supposed that migration influence the reach of their appearance and the intensity of spread. Yet, no evidence exists allowing demonstration of such a proposition. The influence of population movements on the spread of onchocercosis is, on the other hand, quite limited. The group of persons who deserve a special attention in further studies of morbidity are the workers who came to work on a dam, and who can either the carriers of parasite (infection reserve), or to the contrary — may be susceptible to infection with a locally appearing parasite.

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