Health impact

A rapid health impact assessment of the Turkwel Gorge hydroelectric dam and proposed irrigation project

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A rapid health assessment of the Turkwel Gorge hydroelectric dam and proposed irrigation project in Kenya is described. The project will lead to increased risk of a number of communicable diseases including malaria and schistosomiasis, to the human population in the surrounding area. Mitigation measures are available and should be incorporated in the design and operation of the irrigation project to maximise cost-effectiveness.

Keywords: impact assessment; health; Kenya

This paper describes a rapid health impact assessment (HIA) of Turkwel Gorge hydroelectric dam and proposed irrigation project in Kenya, carried out in 1994. The project is situated in a semi-arid region of north west Kenya, on the border between West Pokot and Turkana Districts (Grid reference 35° 5'E, 1° 21'N; Figure 1). As is the case with development projects in many countries, an environmental impact assessment (EIA) was completed, but with insufficient reference to the impact on human health.

Kenya has had serious design, management, operation and maintenance problems with many of its development projects. Some of these have been attributed to a lack of critical review by donors and planners. The problems of the World Bank-funded Bura irrigation scheme were described by Caufield (1996). Technical problems have been immense (Chambers and Moris, 1973). Vector-borne diseases have abounded, yet received little management (PEEM, 1990).

Many of these problems have been acknowledged locally. In the past, some of them could be attributed to a lack of impact assessment. More recently, environmental impact assessment (EIA) statements have been made, but not implemented, and this may be the case with Turkwel dam. At the time of our study, it was not considered to be too late to avoid some of the problems encountered in previous irrigation projects.

The hydroelectric component was completed in December 1991 and consists of a reservoir 40km long, covering 66km² when full. The dam wall is situated...
in a narrow gorge that drops steeply down the escarpment to a plain over which the river meanders until it reaches Lake Turkana. An irrigation project is planned on the valley floor, 3–5km downstream from the dam. This will consist of a 5,213 hectare (ha) irrigation command area growing cash and food crops.

There is a history of drought in the semi-arid areas of Kenya. Famine relief was given to Turkana and West Pokot during the 1970s and 1980s, and in some areas many families were continuously dependent on famine relief for survival. Droughts and food insecurity have led the government to promote agricultural developments in semi-arid regions (Dietz, 1987).
In West Pokot there are approximately 6,100 people per health facility, compared with a national average of 11,300, however, 42% of the district population live beyond a 6.4 km radius of a health facility.

Since they are local, Turkana and Pokot are considered to be two of the main beneficiaries of the irrigation scheme, but it is not known how the predominantly nomadic pastoral communities will take up the agricultural activities. Other irrigation schemes in Kenya have settled migrants from the more populous highland areas. Irrigation schemes in Turkana have been very expensive, with estimated costs over US$50,000 per ha (Cullis and Pacey, 1992).

Methodology

The methodology of this HIA is essentially qualitative, conforming to Birley (1991; 1995) and recently used by Konradsen et al (1997) in Zimbabwe. Rapid assessments are carried out because of shortage of time and money or difficulties of access to project sites and documents. The main requirements for such an assessment are that it should be rapid, simple and structured. It relies on secondary data, key informant interview, and focused group discussion to obtain essentially qualitative, uncertain and incomplete data.

The data are arranged in a simple and structured fashion that enables an outside reviewer to assess strengths and weaknesses and to identify gaps requiring further study. The output is a statement of expected changes in health risk that includes both the positive and negative. This is accompanied by outline recommendations for health risk management that are specific, practical and as acceptable as possible, or that indicate the steps required to formulate detailed management plans through negotiation with the principal stakeholders.

The procedure consists of health hazard identification, health risk assessment and health risk management. A health hazard is defined as having the potential to cause harm to people, whereas a health risk is defined as the likelihood that the potential is realised (Birley, 1995). Hazards for this project were identified because they were already important causes of morbidity and mortality in Kenya, and West Pokot and Turkana in particular, or are health hazards commonly associated with reservoir and irrigation projects. Vector-borne disease hazards are particularly important, but other health hazards are also considered. Other equally important problems include malnutrition, injury and agro-chemical poisoning, but these are outside the scope of this assessment.

The assessment of health risks changes associated with the project is considered under four main headings:

- communities affected (stakeholders);
- community risk factors (community vulnerability as a function of immunity, poverty and behaviour);
- environmental risk factors (bio-physical and social environmental factors);
- institutional risk factors (the capacity, capability and jurisdiction of the health protection agencies).

### Communities affected

The majority of West Pokot inhabitants belong to the Pokot tribe. In 1988, the population there was estimated at 232,000. The immediate project area was sparsely populated; approximately 500 people inhabited the 15km² surrounding the gorge. In 1994, there were small settlements in the reservoir area comprising families of project workers, with an estimated 1,000 people working and living at the dam site.

Turkana district, at the base of the Turkwel Gorge escarpment, is inhabited almost solely by Turkana tribespeople. In 1984, the population of Turkana was 232,740 distributed sparsely over 67,000km² of semi-desert land. Only 30% of the population was settled, the rest being nomadic pastoralists. Pokot and Turkana tribespeople are largely nomadic, relying on goats, cattle and sheep for a living.

The human communities affected by the Turkwel Gorge project are summarised in Table 1.

Historically, there has been an unstable security risk in the region. Pokot and Turkana herders have traditionally engaged in livestock rustling and other armed intertribal conflicts (Dietz, 1987). Between 1981 and 1993, there were frequent armed raids and cattle rustling leading to widespread population displacements.
In the remote area where the project is located there is little infrastructure and few health protection agencies. The government health sector is under-resourced. There are a few non-governmental organisations (NGO) offering medical care, but little preventative work. If health risks are increased by the project then hidden costs would be transferred to a health sector that does not have the resources to respond. New health facilities are planned, but implementation is likely to be delayed unless a specific budget is provided as part of the project. Control of informal immigration is largely through tribal law.

The environmental impact statement associated with the project is stored at Kerio Valley Authority headquarters in Eldoret. Insufficient provision for safeguarding human health was included.

Health capabilities

West Pokot district has 35 static health facilities, including Kapenguria District hospital, with 200 beds; and Ortum Catholic Mission hospital with 120 beds. There are two dispensaries within 30km of the gorge, at Kasei and Amolom. Turkwel Gorge Health Centre, located at the foot of the dam service road, will operate as a sub-district hospital with 20–40 beds. In West Pokot there are approximately 6,100 people per health facility, compared with a national average of 11,300, however, 42% of the district population lives beyond a 6.4km radius of a health facility (Government of Kenya, 1982).

There are 14 static health facilities in Turkana. The government district hospital, with 200 beds, is located at Lodwar in central Turkana, and a sub district hospital at Lokitaung. There are two NGO hospitals at Kakuma and Lokori, as well as four health centres and six dispensaries. Nakwamoru Catholic Health Centre is located 20km downstream of Turkwel Gorge.

Malaria

Review of disease

Malaria is the most prevalent disease in West Pokot and Turkana. Plasmodium falciparum accounts for 80–85% of cases. Health statistics for 1993/94 show that malaria is ranked as the primary cause of morbidity at all health centres visited, accounting for 25–79% of cases. Malaria transmission and vector breeding appear to be perennial, and Mutero et al (1992) found malaria throughout West Pokot, except at 2750m above sea level. Recently there has been an increase in highland malaria throughout the Rift Valley region and many of the health centres visited reported higher numbers of malaria cases than previously recorded.

Community risk factors

The local population has some immunity to malaria, with infection rates exhibiting a general decline with age. Immigrants to the irrigation project from non-endemic areas would experience severe infection in all age groups, with the local population acting as a source of infection. With time, the immigrant adult population will develop a degree of immunity. Immigrant populations from non-malarious areas will be the most vulnerable community group.

Environmental risk factors

Anopheles gambiae has been identified in the region (Cox, 1972) and recent work in Turkana by Clarke et al (1996) suggests that An. arabiensis is the primary vector. Anopheles arabiensis breeds in shallow, open, sun-lit habitats, including irrigation drainage canals, and will quickly exploit temporary pools (Gillies and Coetzee, 1987).

Reservoir Anopheles tend not to breed in open waters on the scale of reservoirs, but breeding sites may be created along lake margins as a result of watering livestock and the subsequent creation of puddles and hoof-prints. Deep reservoirs with regular shorelines and steep margins such as Turkwel reservoir have a low marsh potential and are less likely to support mosquito breeding compared with shallow reservoirs with irregular shorelines and gently sloped margins (Birley, 1991).

Irrigation scheme The introduction of an irrigation scheme on the Kano plain in north-western Kenya raised the population of An. gambiae by 70 times (Surtees et al, 1970), whilst both the Mwea and Hola-Bura irrigation schemes resulted in a switch to perennial rather than seasonal malaria transmission (Service, 1984).

Institutional risk factors

Vector control programmes do not operate in this area. Chloroquine is locally available in health centres, dispensaries and shops, but curative measures are hampered by parasite resistance. Health services are severely stretched during outbreaks of malaria and are unlikely to cope satisfactorily with increased demands placed on resources by a large immigrant population. Facilities should improve when Turkwel Gorge sub-district hospital and a proposed health centre in Turkana become operational. Drug supplies are currently sufficient, but will need to be increased when the irrigation scheme is fully operational.

Conclusion

The assessment concluded that there was an increased risk of malaria at both the reservoir and the irrigation scheme. Although the current population in the
project area has some acquired immunity to malaria, transmission could be raised to high levels all year round as vector breeding sites increase. Immigration of non-immune populations to the irrigation scheme will result in more infections and an increase in the incidence of severe disease. In addition, health facilities are not easily accessible for much of the population and they will be severely stretched during malaria outbreaks.

**Schistosomiasis**

**Review of disease**

*Schistosoma haematobium* (urinary schistosomiasis) and *S. mansoni* (intestinal schistosomiasis) are both endemic in Kenya (Doumenge et al., 1987). Currently, there is no schistosomiasis recorded in the project area. However, its prevalence is nearly always enhanced by the impoundment of water in man-made lakes and associated irrigation schemes, and has occurred in virtually every major dam project in Africa (Brown and Deom, 1973).

**Community risk factors**

Vulnerable communities are those whose occupation or behaviour brings them into contact with infected water. Immigrant construction workers, fisherfolk and farmers from infected areas could introduce the disease in their urine and excreta. If schistosomiasis develops it is likely that it will affect most of the population living along the reservoir and river basin.

Pokot herders will be exposed when watering their animals and carrying out washing activities at the lake shore. Fisherfolk are particularly at risk of schistosomiasis because of exposure during fishing activities. Irrigation project farmers will be exposed during farming activities, and if adequate water supplies are not provided, their families can be exposed during washing and recreational activities.

**Environmental risk factors**

Reservoir Permanent water leads to greatly increased numbers of snail intermediate hosts of schistosomiasis (Service, 1984). In Africa, Lakes Kariba, Nasser and Volta were colonised by snail intermediate hosts (Brown and Deom, 1973). There has been no survey for vector snails at Turkwel, but it is likely that they are present along feeder rivers. Vegetation developing on the banks of the reservoir is likely to provide favourable breeding sites.

**Irrigation project** Schistosomiasis is a major disease associated with irrigation, especially of rice and cotton, since vector snails breed in irrigated fields and more importantly in irrigation ditches and canals. At Mwea irrigation scheme, Kenya, no children were infected when the project was implemented in 1956, but by 1980 prevalence was 70%. Schistosomiasis has not developed in the Turkwel area so far because the water supply was seasonal, leading to natural control of snails. It is likely that the disease will occur in future because the irrigation scheme will be supplied with water year round and natural control of snails will no longer exist.

**Institutional risk factors**

Schistosomiasis is cured with a single dose of Praziquantel. At present, diagnosis of schistosomiasis cannot be carried out at Turkwel Gorge health centre. There are no preventive measures against schistosomiasis in operation.

**Conclusion**

The assessment concluded that there was a high risk of importation of schistosomiasis from other parts of Kenya following the influx of a large immigrant population to the scheme. Although there is no information about snail vectors in the area, it is likely that both the reservoir and the irrigation scheme will become colonised. Nomadic herders, fisherfolk and farmers and their families are all high risk groups for schistosomiasis.

**Visceral leishmaniasis**

**Review of disease**

Visceral leishmaniasis (kala-azar, *Leishmania donovani*) is a severe and often fatal vector-borne disease in West Pokot and Turkana (Wykoff et al., 1969; Mutero et al., 1992). It tends to occur in semi-arid, sparsely populated regions with limited medical resources and the disease is usually sporadic and focal, commonly affecting young males. Outbreaks and epidemics have occurred in association with immigrant groups and population movements and in more settled areas are associated with agricultural developments. Under these situations all age groups are susceptible, with increasing numbers of infections in younger children and infants (Ashford and Smith, 1985).
Community risk factors

In West Pokot, kala-azar is most common in low lying regions and along river valleys, exhibiting a general decline in infection rates with altitude (Mutero et al., 1992). Health data from Kapenguria and Ortum hospitals indicate that kala-azar is more common in males than females, and in adults than children, suggesting an occupational component of exposure to the parasite. Cowherders using termite mounds to watch over grazing animals are more likely to be bitten by sandflies, which commonly rest in these sites.

Environmental risk factors

In West Pokot, Phlebotomus martini is responsible for kala-azar transmission (Mutinga and Ngoka, 1978) and epidemiological studies indicate a close correlation between incidence of human infection and the presence of eroded termite mounds — favoured sites for the vector (Mutinga, 1986). Sandfly breeding sites also include cracks in the ground and animal burrows, which are present around Turkwel.

Sandfly numbers may be altered by gross environmental changes such as agricultural development, and the raising of water tables (Ashford, 1986). From 1984 there has been a major epidemic of kala-azar in southern Sudan, with over 30,000 deaths. It has been postulated that the altered water regime caused by the construction of the Owen Falls Dam led to widespread flooding and woodland destruction, creating breeding sites for the sandfly vector and resulting in the epidemic (Ashford and Thomson, 1991).

Institutional risk factors

Practical control measures for kala-azar in Africa are extremely limited (Ashford, 1986) and consist primarily of drug treatment. This is expensive and requires a supply of syringes, injectable drugs and medical supervision. Drug supplies are unreliable.

Conclusions

The assessment concluded that, as leishmaniasis is a relatively common disease in West Pokot and Turkana, there is a medium risk that the immigration of large numbers of susceptible people into the region will lead to an increase in the prevalence of this disease. Currently, too little is known about the ecology and behaviour of sandflies to make reliable predictions as to the effect of increased humidity, raised water table, and other environmental changes on sandfly longevity and population size. Further research is required.

Rift Valley fever

Review of disease

Rift Valley fever (RVF), an arbovirus transmitted by mosquitoes, was historically a disease of livestock appearing in transitory epidemics along the Rift Valley every 5–10 years, with moderate mortality in sheep and cattle and a high incidence of abortion and still birth (Davies et al., 1985). Outbreaks were correlated with widespread periods of heavy rainfall that inundated mosquito habitats. More recently, RVF has caused human fatalities in epidemics in West and North Africa (Jobin, 1989).

Community risk factors

Most fatalities due to RVF virus have occurred among herders congregated around reservoirs filling from

Figure 2. Gonorrhoea cases as percentage of total cases at Turkwel Gorge dispensary, January 1990 to July 1994
A high human population resulting from immigration and settlement could lead to an increase in water-borne diseases, if adequate water supplies and methods of excreta management are not developed in time.

Annual rains (Jobin, 1989). Nomadic herders using Turkwel reservoir for watering animals will be particularly vulnerable if RVF is present in the region.

Environmental risk factors

RVF virus has become associated with dam projects in North and West Africa. In 1987, construction of dams in West Africa triggered an epidemic of RVF which killed over 200 people. RVF is sometimes transmitted in extremely dry areas under intensive irrigation; this has occurred in Egypt and Sudan (Jobin, 1989). Extensive epidemics in Egypt, in 1977-1978, killed hundreds of animals and thousands of people were infected, with over 600 deaths (Jobin, 1989).

Institutional risk factors

RVF vaccines are available for animals and humans but the human vaccine is expensive and is often reserved for persons in high risk occupations. There is no cure for RVF, and health services are likely to have difficulty in recognising an outbreak.

Conclusion

The assessment concluded that the project presents a health risk from RVF because it provides the necessary mix of people, water, animals and mosquitoes which could facilitate an outbreak of the virus. Herd­ers are particularly at risk because of their close association with livestock.

Sexually transmitted diseases

Review of diseases

Progressive urbanisation and changes in traditional customs have led to an increase in sexually transmitted diseases (STDs) in Kenya. Figure 2 shows the reporting of gonorrhoea cases at Turkwel Gorge Dispensary from January 1990 to May 1994. During the construction phase of the dam, gonorrhoea accounted for up to 9% of all cases treated. STDs are not recorded as major causes of morbidity in the other health facilities in the region.

Community and environmental risk factors

The social environment of large construction sites frequently provides favourable conditions for the transmission of STDs. Construction workers are a vulnerable community because they often live separated from their partners, have sufficiently high incomes to pay sex workers, and travel extensively. A study in Nairobi observed that 94% of those infected with STDs were working more than 400km from their home area (Verhagen and Gemert, 1972). Key informant interviews revealed that female commercial sex workers operated at the dam; if they are present at the gorge, most communities are at risk.

Transmission is likely to be intensified when construction takes place in a remote rural locality with no other sources of entertainment and with an impoverished local community.

Institutional risk factors

Most STDs are treatable, although there is some evidence that women are reluctant to attend health facilities for treatment. Although local laboratory diagnostic capabilities are poor, treatment with broad spectrum antibiotics may be sufficient and specific diagnosis may not be necessary. Antibiotics, including tetracycline and chloramphenicol were available at most of the health facilities visited.

There is no cure for AIDS and it is likely that local capability for diagnosis and treatment is poor. An HIV prevention programme was underway in Kitale district hospital, and AIDS prevention posters were seen in most of the health centres visited.

The incidence of STDs can be limited by education programmes coupled with family planning, the distribution of condoms and support for family groups. Construction companies should make plans for the control of STDs associated with their workforce. There was no evidence that this was happening.

Conclusion

The assessment concluded that there was an increased risk of STDs as a consequence of the project.

Water-washed and water-borne diseases

Review of diseases

Skin and eye infections, as well as diarrhoea and gastro-intestinal infections including ascariasis and giardiasis are major causes of morbidity and mortality in most parts of the developing world, including north west Kenya. Diarrhoeal disease accounts for 6-8% of morbidity in the region. Skin and eye diseases account for 5-9% and 3-7.5% of cases respectively. Cholera was introduced into Kenya in 1970 and an outbreak occurred in West Pokot in 1981 (Dietz, 1987). Diarrhoea can be classed as a health risk with a high...
frequency and high severity in children. By contrast, infections such as ascariasis can be classed as high frequency but low severity.

Community risk factors

Many of these diseases are associated with poor personal hygiene, handling of infected animals, and ingestion of contaminated food and water. There is often a lack of acquired immunity and individuals may become infected many times with a single serological type (Feacham et al., 1983). A high human population resulting from immigration and settlement could lead to an increase in water-borne diseases, if adequate water supplies and methods of excreta management are not developed in time, as happened on the Bura scheme on the Tana River (PEEM, 1990).

All communities that do not have a clean and plentiful water supply are at risk from these diseases. The availability of only small amounts of water makes the practice of good personal and household hygiene difficult, or even impossible.

Environmental risk factors

The main environmental factors are likely to include a shortage of relatively clean drinking and washing water. Piped water supplies were available at Turkwel Gorge for the dam workers, but typhoid cases were reported at the dam site. The water supply may have been contaminated as a result of poor maintenance. Other communities obtained water either from the reservoir (Pokot herders and fisherfolk) or from Turkwel river (Turkana herders). There were some shallow wells and boreholes which were used by local communities.

Increased quantity of water is often more important than improved quality for control of endemic diarrhoea (Cairncross, 1990). Communities need convenient access to between 30 and 50 litres of water per person per day, but this must be accompanied by sustained health education in order to have a health benefit.

Institutional risk factors

Local health staff are experienced in dealing with diarrhoea and oral rehydration, as well as skin and eye diseases. Trachoma, a common eye complaint, is easily cured using achromycin ointment, which was available at most of the health facilities visited. Antibiotics, including amoxil and chloramphenicol for treatment of typhoid, and flagyl for treatment of amoebiasis were available at health facilities as were rehydration salts. Many pathogens responsible for this group of diseases are resistant to antibiotics.

Conclusions

The assessment concluded that there is a significant risk of increase in the incidence of many of these diseases as a result of the hydroelectric project, and in particular the irrigation project. This is most likely in the early stages of development before adequate water supplies and excreta disposal measures have been fully implemented. It is not known whether the irrigation plans include sufficient provision for water supply and sanitation. Typically, they do not. If and when an improved water supply and sanitation is implemented, the incidence of water-washed diseases should decrease.

Risk management and mitigation measures

There is a need to identify, develop, and, wherever possible, test suitable mitigation measures to reduce the health risks associated with this development project. Epidemiological surveillance is required to establish the importance of various diseases on the project, and to monitor changes. This will be aided considerably if health services begin screening the immigrant population at the start of the project.

Malaria and schistosomiasis

Successful vector control is dependent on the elimination of project-related mosquito and snail breeding sites, as a result of good reservoir and irrigation design and management. Systematic fluctuations in water level in reservoirs can reduce the breeding of snail vectors of schistosomiasis and many malaria and arbovirus vector mosquito species, although An. gambiae populations can be made worse by leaving puddles.

A community-led health education programme promoting awareness of malaria and schistosomiasis, especially amongst the immigrant population, could be implemented, and should include recognition of symptoms and promotion of personal protection measures. Recommendations for health education are of little value without an analysis of how often, and with what staff and budget they should be carried out. A preliminary step in the process of health education is a survey to determine community knowledge, attitude and practice.

The more sophisticated the method of irrigation, the less likely it is to encourage vector-borne disease transmission. Thus, uncontrolled flooding with little effective drainage presents the greatest risk, whilst piped water and piped drainage are usually best if they can be maintained. Borrow pits and depressions should be filled-in, especially near villages.

Malaria

Malaria control includes: early diagnosis and treatment; promotion of personal protection methods such as impregnated bed-nets, mosquito coils and prophylaxis; and removal of potential mosquito breeding sites, particularly those close to human habitation. Chemoprophylaxis may be cost-effective during the
The use of irrigation canals for bathing by small children is considered to be the most important factor in continuing or increasing schistosomiasis transmission: it is an advantage if villages are provided with snail-free bathing areas

settlement period, particularly for the most vulnerable groups — children below five and pregnant women.

Conventional mosquito vector control will be difficult owing to the shortage of trained staff, extensive mosquito breeding habitats and the costs of residual house spraying. A community-based, income-generating, bed-net project could be an effective malaria control strategy.

Siting of housing with regard to location of potential mosquito breeding sites requires careful consideration. The normal flight range for mosquitoes is about 1.5–2.0km (Birley, 1991) making villagers within this range of breeding sites especially vulnerable. Housing design may lead to a decrease in risk from mosquitoes. Many malaria vectors rest indoors and are usually less numerous in housing with properly rendered walls and ceilings. Screening greatly reduces the risk from mosquitoes biting indoors.

Schistosomiasis

In irrigation schemes, the main problems usually arise in small channels and drains adjacent to irrigated fields and night storage reservoirs. Regular de-weeding and cleaning prevent accumulation of silt and vegetation, which can lead to mosquito and snail breeding. Sluicing and flushing, with either automatic siphons or hand-operated gates is often effective.

Responsibility for maintenance should be delegated to local irrigation management committees who require an adequate annual budget for maintenance operations, funded from a water tax payable by farmers. Field drains should be designed to empty into the river and not into depressions. Irrigation schemes should be designed so as to eliminate night storage reservoirs or at least locate them away from human settlements (Jobin, 1992).

Vector snails have a restricted tolerance to water flow and can only survive and breed at flow rates below 0.3m/sec. The maintenance of a fast flow of water through irrigation canals is an effective control method, but this requires the canals to be lined with concrete and maintained free of vegetation and silt. This type of construction is expensive, and maintenance requires considerable investment of labour and a high degree of vigilance.

Farmers should be encouraged to remove weeds and use them as organic fertiliser or cattle fodder. If canal clearing is done manually, it exposes workers to schistosomiasis and so should be done early in the morning when fewer infective cercariae are present (Konradsen and Chimbari, 1993).

The use of molluscicides has proved to be effective in large-scale irrigation schemes in Africa (Bolton, 1988). It requires well trained manpower, sufficient funding and equipment, and knowledge of seasonality (Christensen et al, 1987), and is therefore very expensive. Other irrigation schemes in Kenya operate a mollusciding programme in which the entire scheme is treated three times a year using Bayluscide.

In the long term, control measures have unimpressive results: transmission increased considerably at the Hola irrigation scheme, despite the provision of village water supplies including shower and laundry facilities, pit latrines and a regular mollusciding programme (Smith, 1977). The use of irrigation canals for bathing by small children is considered to be the most important factor in continuing or increasing schistosomiasis transmission. It is an advantage if villages are provided with snail-free bathing areas. These should be centrally sited, concrete lined if possible, well maintained, treated with molluscicides and surveyed for snail colonisation. This is often impractical.

Immigrant populations should be screened for schistosomiasis and any infected individuals should be treated with a single dose of praziquantel. Regular surveillance of suitable habitats for snail populations and identification of potential intermediate host species should be undertaken. Licensing of fishing in the reservoir area should prevent the unsupervised immigration of fisherfolk from regions endemic for schistosomiasis. However, there remains a danger that snails will be imported in fishing nets. As access to Turkwel reservoir is by a single guarded entrance through the Nasolot reserve, the opportunity exists to monitor nets and human populations, to reduce the risk of importation of vectors and parasites.

Visceral leishmaniasis

Mass screening programmes for kala-azar, or active case detection, followed by treatment of cases would limit availability of the parasites to sandfly vectors, as there is no known animal reservoir (Ashford, 1986). Large-scale destruction of termite mounds near to homes has been implemented in Kitui and Machakos in Kenya (Muttinga, 1986), although the level of success has not been reported. Ortum hospital has begun a programme for the clearance of termite mounds, allied with treatment using pentostam: the results should be assessed. Vector control is usually by pesticide and is largely inappropriate for the prevention of kala-azar.

Rift Valley fever

To avoid an outbreak of RVF, environmental improvements similar to those recommended for the
control of malaria vectors should be implemented, with the addition of adaptations to the reservoir operation to allow rapid drawdown at critical times of year. The virus levels of livestock should be monitored at least twice a year to warn of potential outbreaks. If the virus levels in the human population rise, and the risk of an epidemic appears to be high, general mosquito control measures should be applied within the reservoir. Vector control measures will help to reduce the incidence of the common water-washed diseases. Latrines should be built at least 15 metres away from any water supply or household, and downhill from water sources. The community should be assisted to design and locate latrines that accord with their own preferences. Water supply systems should be located according to the community preference and designed for local maintenance. Open reservoirs should be avoided, or at least fenced to prevent their use for watering animals.

**Conclusion**

The analysis shows that the Turkwel Gorge reservoir and proposed irrigation project will lead to increased risk of a number of communicable diseases, including malaria and schistosomiasis, to the human population inhabiting the surrounding area (Tables 2 and 3). Mitigation measures are available, and should be incorporated in the design and operation of the irrigation project to maximise cost-effectiveness. A specific budget should be included for this purpose and an inter-sectoral steering committee should be formed that includes representatives from the health sector as well as irrigation, agriculture, economic planning and the KVDA (Kerio Valley Development Authority).

### Table 2. Generalized health impact assessment table: Pokot nomads

<table>
<thead>
<tr>
<th>Project</th>
<th>Community group</th>
<th>Institutional risk factors</th>
<th>Health risk associated with project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community group</td>
<td>Turkwel Gorge hydroelectric dam and reservoir, North-west Kenya</td>
<td>Curative but drug resistance and access to health facilities difficult.</td>
<td>High and expected to increase</td>
</tr>
<tr>
<td>Health hazard</td>
<td>Community risk factors</td>
<td>Environmental risk factors</td>
<td>Curative, No surveillance and vector control at present.</td>
</tr>
<tr>
<td>Malaria</td>
<td>Primary cause of morbidity and mortality. Immune status may be low due to seasonal transmission.</td>
<td>Extension of vector breeding season and provision of additional vector breeding sites expected. Parasite present.</td>
<td>Curative, but drugs expensive and in short supply.</td>
</tr>
<tr>
<td>Schistosomiasis</td>
<td>Exposure to parasite expected when watering animals, and with washing activities around the reservoir.</td>
<td>Vector snail expected to colonize the reservoir. Parasite not present in immediate area but danger of introduction with immigration to site.</td>
<td>Curative, but access to health facilities difficult.</td>
</tr>
<tr>
<td>Visceral leishmaniasis</td>
<td>Population susceptible, high morbidity and mortality at present.</td>
<td>Vector inhabits old termite mounds and cracks in ground, usually in undisturbed areas. Parasite present.</td>
<td>Medium</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>Nomadic herders in close association with grazing animals particularly at risk.</td>
<td>Virus associated with high water levels and animals grazing around reservoirs and irrigation projects.</td>
<td>No surveillance or vector control at present.</td>
</tr>
<tr>
<td>Water-washed diseases</td>
<td>Important cause of morbidity.</td>
<td>Praziquantel is expensive and in short supply.</td>
<td>Medium</td>
</tr>
</tbody>
</table>

**Sexually transmitted diseases**

The incidence of STDs can be limited by the distribution and use of condoms, combined with a active programme of health education. Care should also be taken to ensure that female-headed households have equal entitlement to farming lands. Migrant labourers and settlers should be moved as family groups, and the local community should be empowered to control the behaviour of workers located in their midst.

**Water-borne and water-washed diseases**

The provision of safe water supplies and adequate facilities for the disposal of excreta and waste water will help to reduce the incidence of the common water-washed diseases. Latrines should be built at least 15 metres away from any water supply or household, and downhill from water sources. The community should be assisted to design and locate latrines that accord with their own preferences. Water supply systems should be located according to the community preference and designed for local maintenance. Open reservoirs should be avoided, or at least fenced to prevent their use for watering animals.
### Table 3. Generalized health impact assessment table for vector-borne diseases: farmers and families

<table>
<thead>
<tr>
<th>Project</th>
<th>Community group</th>
<th>Health hazard</th>
<th>Community risk factors</th>
<th>Environmental risk factors</th>
<th>Institutional risk factors</th>
<th>Health risk associated with project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkwel Gorge Irrigation project, North-west Kenya</td>
<td>Irrigation project farmers and families</td>
<td>Malana</td>
<td>Immigration of susceptible people expected. Currently primary cause of morbidity and mortality in local population.</td>
<td>Provision of additional mosquito breeding sites in rice fields and poorly maintained irrigation ditches close to human settlements expected. Extension of vector breeding season expected.</td>
<td>Curative. Cholorquine available at health centres and shops but drug resistance. No surveillance and vector control at present.</td>
<td>High and expected to increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schistosomiasis</td>
<td>Immigration of susceptible people expected. Introduction of vector snail to irrigation ditches expected. Introduction of parasite expected with human irrigation.</td>
<td>Vector sandfly inhabits old termite mounds and cracks in ground in undisturbed areas. Parasite present.</td>
<td>Curative. No surveillance and control at present. Praziquantel is expensive and unlikely to be stocked.</td>
<td>Zero at present but expected to increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visceral leishmaniasis</td>
<td>Influx of susceptible population expected.</td>
<td></td>
<td>Curative. but pentostam expensive and in short supply. Available in private hospitals. No surveillance or control at present.</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### References

- Government of Kenya (1982), "Health facilities in West Pokot district".
- F Konradsen and M Chimbari (1993), "Health impact assessment Mupure Irrigation Project, Zimbabwe", *Health Impact Programme*, Liverpool School of Tropical Medicine, unpublished report.
Rapid health impact assessment


D H Smith (1977), "Bura Irrigation Settlement Project — project planning report", Public Health Annexe.


