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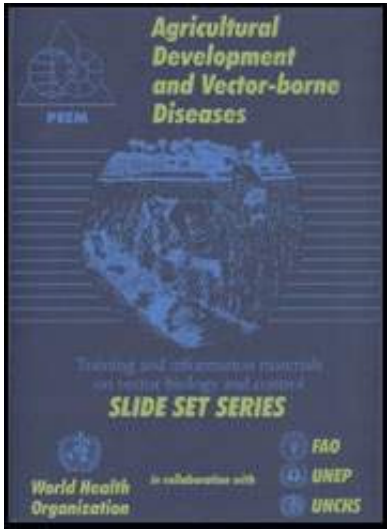

Agricultural Development and Vector-Borne Diseases (FAO - HABITAT - UNEP - WHO, 1996, 91 p.)

Topic D: Disease transmission, with special reference to schistosomiasis

- List of slides
- D.1 Diagram: How development can affect health
- D.2 Diagram: Pathways of disease transmission in water resources development projects
- D.3 Table: Contact frequency related to disease transmission
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- D.7 Transmission risk of schistosomiasis related to inland fisheries in Mali
- D.8 Ford across stream, Puerto Rico, creating a potential transmission focus for schistosomiasis
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Agricultural Development and Vector-Borne Diseases (FAO - HABITAT - UNEP - WHO, 1996, 91 p.)

Topic D: Disease transmission, with special reference to schistosomiasis

List of slides

D.1 Diagram: How development can affect health

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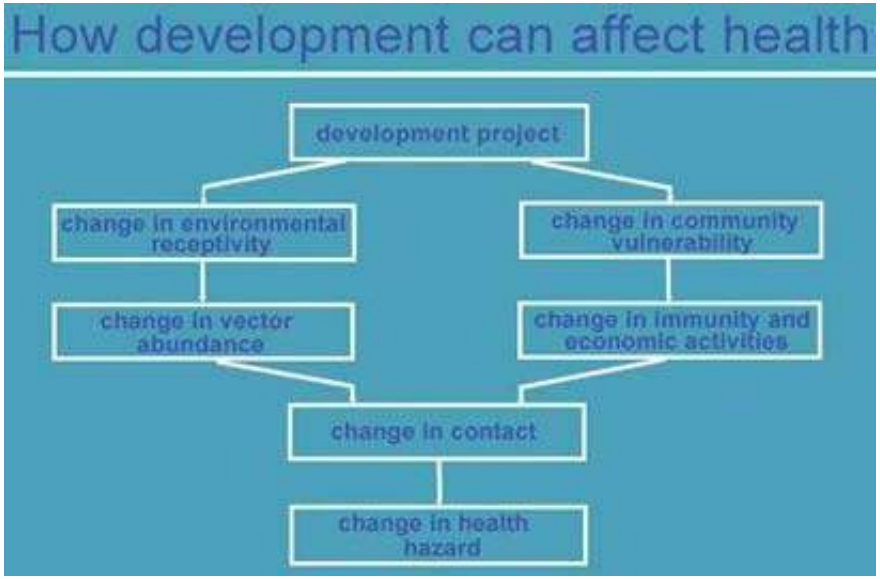
Credit individual slides:

World Health Organization
D.1, D.2, D.3, D.8
Danish Bilharziasis Laboratory
D.4, D.5, D.6, D.7
Food and Agriculture Organization of the United Nations
D.9
Agricultural University Wageningen, Netherlands:
D.10

D.1 Diagram: How development can affect health



Slide D.1 Diagram: How development can affect health

Disease and development are critically connected in many places where poverty, low environmental standards and lack of sufficient resources to ensure adequate environmental management and health care go hand in hand.

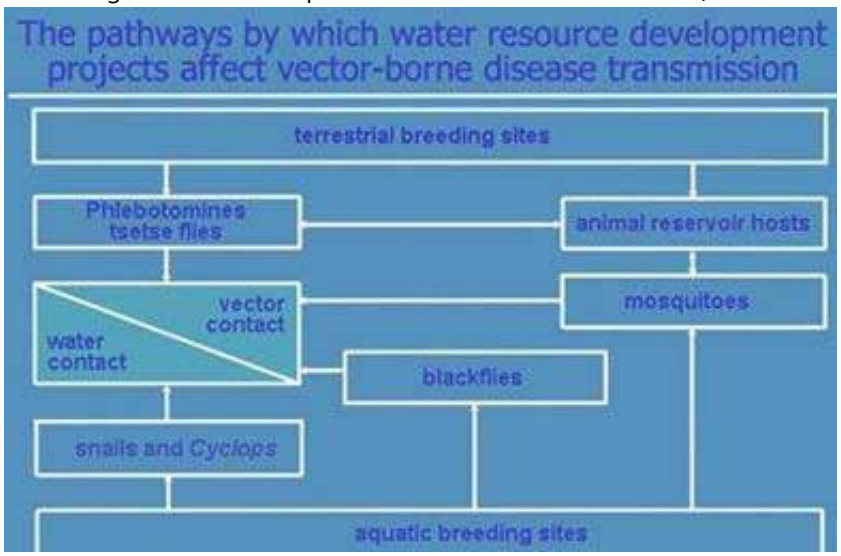
The two main pathways by which agricultural development will influence the human health status are the change in environmental receptivity and the change in community vulnerability.

Environmental receptivity covers vector ecology and biology: it may include changes in vector abundance, in the genetic composition of species complexes, in the longevity of vectors and in the resistance of vector (and the parasites they carry) to certain chemicals such as insecticides or drugs.

Community vulnerability may be affected by changes in economic activities, and in the settlement, re-settlement and migration of people with different levels of immune status or carrying different strains of parasites.

The health services will have to face the resulting new situation, and may or may not have the capacity to deal with it. Whatever the case may be, it is up to the sectors responsible for development to ensure that adverse health impacts are limited to a minimum and that health opportunities are used to a maximum benefit of local communities.

D.2 Diagram: Pathways of disease transmission in water resources development projects



Slide D.2 Diagram: Pathways of disease transmission in water resources development projects

Agricultural development implies changes in the hydrology and the land use patterns in a large area. Thus, both terrestrial and aquatic breeding sites of disease vectors will be affected. The aquatic breeding sites produce vectors of malaria, arboviruses and the filariases (including onchocerciasis). Changes in man-vector contact are reflected in changed incidence rates. Snails and water fleas, also depending on aquatic habitats, will have an impact on the schistosomiasis and *dracunculiasis* (see below) situation. On the other hand, changes in the incidence of sleeping sickness and leishmaniasis are associated with modifications in terrestrial ecosystems. Vegetation cover is a crucial parameter for some malaria vectors, as it is a determinant of relative humidity.

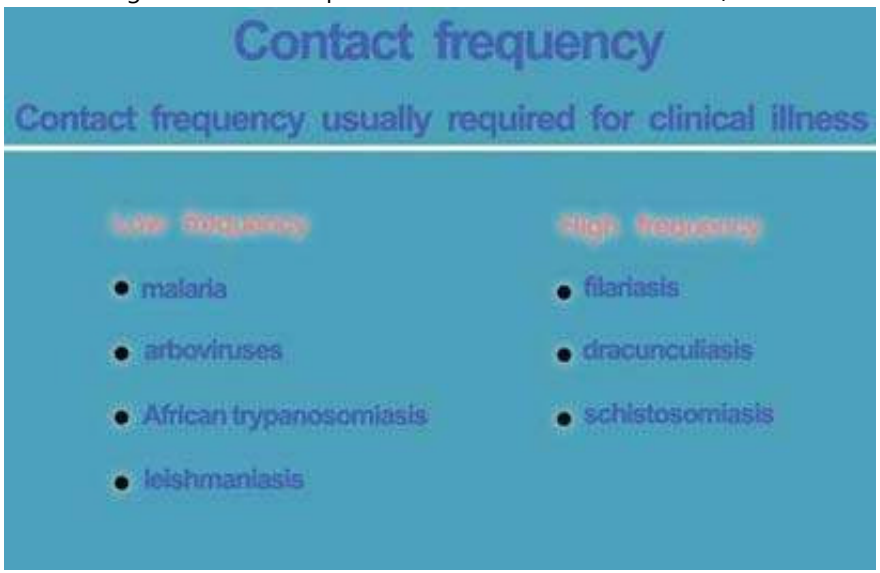
Dracunculiasis or Guinea worm infection is a vector-borne disease transmitted by water fleas, aquatic copepods, which serve as intermediate hosts in the life cycle of the parasite *Dracunculus medinensis.* Some ten years ago, its distribution

included most of tropical semi-arid Africa as well as parts of India and Pakistan. Thanks to the efforts coordinated by the World Health Organization, India and Pakistan will soon be certified as being free of the disease and its area of distribution in Africa has decreased considerably - global elimination of the disease as a public health problem is foreseen by the end of the century.

The transmission of Guinea worm infection exclusively depends on drinking contaminated water, i.e. water with infected water fleas. The disease is caused by a round worm about one meter in length which lives under the surface of the skin. Disability occurs when the female worm emerges, creating a painful blister usually on one of the lower limbs. Secondary infections may further aggravate the affliction. When a Guinea worm blister is immersed in water, the worm releases larvae, which infect the freshwater copepods. Water contact patterns may be related to routine household or agricultural use of water, but people often enter the water to relief the burning pain of the blister.

The disability prohibits walking, working and even routine household activities. The nature of the transmission allows inexpensive, community-based control methods, including health education, providing safe drinking water, applying filters when potentially infected water is used for drinking, and boiling water. The impact of the disease on economic productivity is estimated to be high: a World Bank study of the impact of dracunculiasis in the rice growing belt of Nigeria concluded that rice production may be doubled with the elimination of the disease.

D.3 Table: Contact frequency related to disease transmission



Slide D.3 Table: Contact frequency related to disease transmission

Contact frequency related to disease transmission. For some diseases only one infective mosquito bite is sufficient to result in clinical illness. This is notably so in the case of malaria: not only do a large number of so-called sporozoites get injected into the bloodstream, but the parasites undergo further multiplication in the liver before developing into merozoites that infect red blood cells. For other diseases, such as schistosomiasis, only prolonged exposure leads to clinical illness. Such parasites do not multiply in their definitive host, but as the parasite load builds up over the years, clinical symptoms will gradually become apparent.

D.4 Small holder irrigation in Mali, creating an increased risk for schistosomiasis transmission

Slide D.4 Small holder irrigation in Mali, creating an increased risk for schistosomiasis transmission

Small holder irrigation (in this slide in Mali) creates an increased risk for schistosomiasis transmission, particularly in connection with seepage, hydraulic structures that favour vector breeding and insufficient drainage.

Such increased risks depend on a number of factors:

- **the creation of suitable habitats for snails (reservoirs, hydraulic structures, canals with slow-flowing water and with abundant aquatic weeds)**
- **the spatial distribution of human settlements in the irrigation scheme in relation to various water contact points**
- **human behaviour in terms of agricultural practices and domestic water use, and with respect to sanitation**

The risks can be off-set by proper environmental management measures. Disease situations that have arisen as a result of the introduction of small-holder irrigation need to be addressed by the health services with surveillance and drug distribution programmes.

Small-holder irrigation tends to be more prone to the creation of risk factors, mainly because it is usually less sophisticated than larger state or privately run schemes. This is, however, not necessarily true: in Zimbabwe small-holder farmers have been successfully set up to run a sprinkler irrigation system, which entails little or no health risks.

D.5 Dense snail population in reservoir, Mali

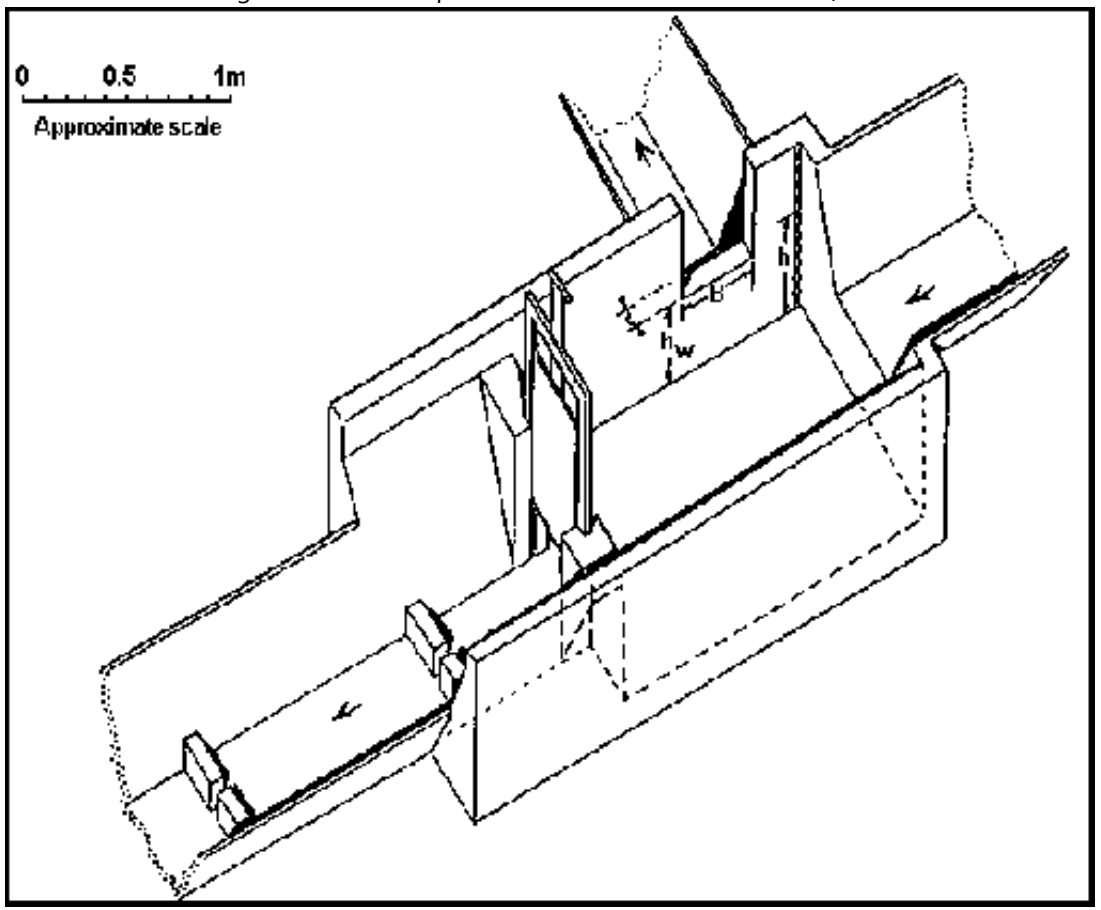
Slide D.5 Dense snail population in reservoir, Mali

Reservoirs, in particular night storage reservoirs, provide the perfect habitat for intermediate host snails of schistosomiasis. Irrigation and drainage canals also contribute importantly, especially those where me flow is slow and where there is

an abundance of aquatic weeds. Aquatic weed growth is usually more prominent in drainage canals, due to the run off of fertilizer.

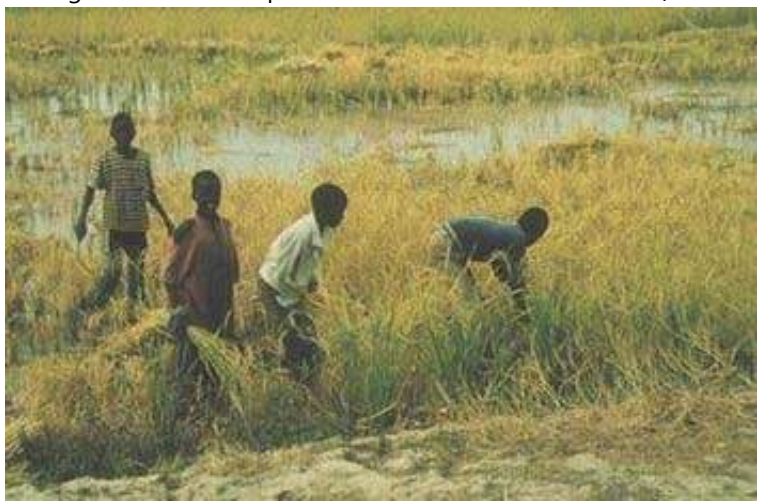
Some hydraulic structures in irrigation schemes also mm into snail habitats and may become major transmission sites if children use them for swimming. Duckbill weirs are notorious as transmission sites.

Studies of the Blair Research Laboratory and the Overseas Development Unit of Hydraulics Research/Wallingford have tested designs for self draining structures in the Mushandike Small-holder Irrigation Scheme. Together with general land-leveling, lined canals with an optimal gradient and the provision of latrines in the fields, the introduction of these structures led to a substantial decrease in transmission risks. An example of a free-darining off-take design is presented on the next page.



Free draining off-take design for Mushandike, from: *Schistosomiasis control measures for small irrigation schemes in Zimbabwe*, by M. Chimbari, S.K. Chandiwana, B. Ndlela, P.D. Ndhlovu, R.J. Chitsiko, A.J. Thomson and P. Bolton, Report OD 128, Hydraulics Research, Wallingford, UK (1993)

D.6 Irrigated rice production, increased transmission risk because of water contact patterns, Mali



Slide D.6 Irrigated rice production, increased transmission risk because of water contact patterns, Mali

The most important crops in terms of schistosomiasis transmission risks are rice and sugar cane. Contrary to popular belief, little or no transmission takes place in the irrigated rice fields, where water temperature tends to be to elevated for the snails. Also, in rice production systems there are periods in the cropping cycle when fields are left to dry and canals are drained. Sugar cane production requires larger quantities of water on a permanent basis, which reflects in high risk levels. The social structure of populations working in commercially run sugar cane plantations, and the use of seasonal labour, possibly coming in from infected areas and settling in temporary living quarters with little or no sanitary facilities, further adds to these risk levels.

D.7 Transmission risk of schistosomiasis related to inland fisheries in Mali

Slide D.7 Transmission risk of schistosomiasis related to inland fisheries in Mali

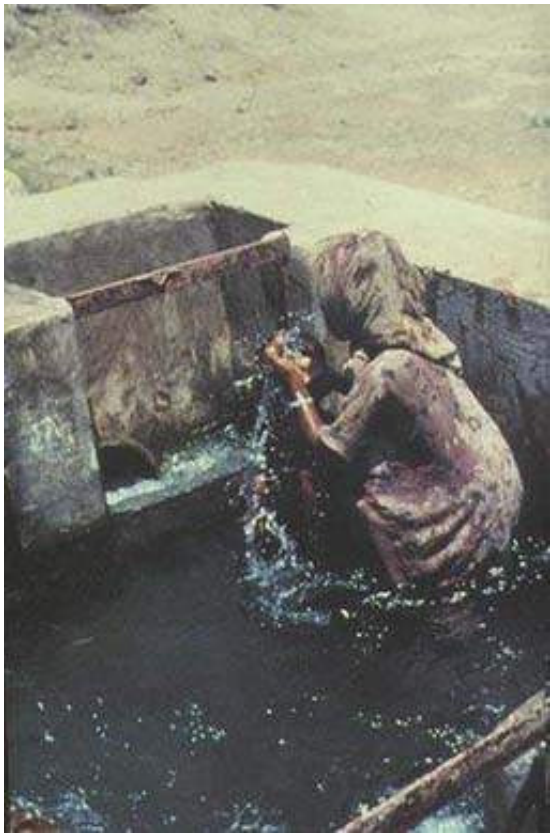
Aquaculture is often cited as another source of schistosomiasis infection, and it may be when pisciculture of freshwater fish is concerned. Risks are usually reduced if the choice of fish ensures little or no aquatic weeds (for this purpose, the fish culture may have a mixture of marketable fish and fish that consume aquatic weeds), or, even better, if the fish species selected eats snails. In fish ponds with steep walls, water contact of fishermen may be negligible, but when the ponds have shallow shores fishermen may wade into the water to capture fish.

D.8 Ford across stream, Puerto Rico, creating a potential transmission focus for schistosomiasis

Slide D.8 Ford across stream, Puerto Rico, creating a potential transmission focus for schistosomiasis

In addition to agricultural practices, peoples' movements in rural areas may pose risks, for instance at places where they have to cross streams or creeks and where water contact may be unavoidable.

D.9 Irrigation turn out (and bath), Yemen, a potential transmission focus for schistosomiasis



Slide D.9 Irrigation turn out (and bath), Yemen, a potential transmission focus for schistosomiasis

Many hydraulic structures designed for water management in the scheme become multipurpose structures when local communities start using them for bathing, washing laundry and dishes and watering cattle.

D.10 Collecting water from a canal, Sudan

Slide D.10 Collecting water from a canal, Sudan

Rural communities involved in large scale irrigated agriculture (such as the area shown in this slide, in the Sudan) depend for their water supply on the irrigation and drainage canals. In these areas ground water is often saline, because of the percolation of nutrients and fertilizer, so wells are not an option. If they can avoid it, members of such communities (usually the women) will not take water from drainage canals, which may be bitter because of fertilizer run-off and pesticide and herbicide residues. As a result, they may have to carry their water over a distance of several kilometers or, in more affluent rural communities, they can buy it from a water trader at a price several times higher then the price their urban counterparts pay for piped water. The lack of adequate sanitation in these communities ensures that the life cycle of the *Schistosoma* parasite is effectively maintained.

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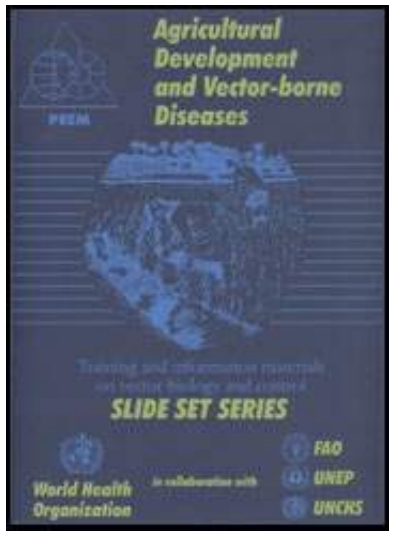

Agricultural Development and Vector-Borne Diseases (FAO - HABITAT - UNEP - WHO, 1996, 91 p.)

Topic E: Land use, vegetation and crops

- List of slides
- E.1 View of a varied catchment topography and vegetation in the Philippines
- E.2 Forest clearing in Thailand
- E.3 Forest clearing and shifting cultivation in Thailand
- E.4 Rice cultivation following deforestation
- E.5 Shifting cultivation and upland rice in India
- E.6 Shifting cultivation and upland rice in Thailand
- E.7 Forest workers in South East Asia
- E.8 Camp of collectors of Brazil nuts in the Amazon region
- E.9 Cutting firewood near Penang, Malaysia
- E.10 Collecting and transporting wood for the market, Ethiopia
- E.11 Resin tapping in a pine forest, Viet Nam
- E.12 Rubber plantation inter-cropped with pineapple, Thailand
- E.13 Gum tapping in Indonesia
- E.14 Coffee picking in Colombia
- E.15 Coffee plantation shaded by figtrees, Ethiopia

E.16 Fodder collection in India
E.17 Coconuts and cattle in Western Samoa
E.18 Introducing forestry in areas in India with problems of waterlogging and salinity
E.19 Pioneer planting in a Brazilian forest with a risk of leishmaniasis transmission
E.20 A papaya plantation in Mauritania
E.21 Cassava production in Mozambique
E.22 Cassava production in Indonesia
E.23 Sugar cane field adjacent to rice paddy in Tamil Nadu, South India
E.24 Close up of sugar cane crop, Tamil Nadu, South India
E.25 Terraced rice fields in Nepal
E.26 Lowland irrigated rice in southern Asia
E.27 Rice field, bush and dwelling, Bali, Indonesia

Agricultural Development and Vector-Borne Diseases (FAO - HABITAT - UNEP - WHO, 1996, 91 p.)

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E.25 Terraced rice fields in Nepal

E.26 Lowland irrigated rice in southern Asia

E.27 Rice field, bush and dwelling, Bali, Indonesia

Credit individual slides:

World Health Organization
E.7, E.8, E.15, E.19, E.26
Food and Agriculture Organization of the United Nations
E.1, E.2, E.3, E.4, E.5, E.6, E.9, E.10, E.11, E.12. E.13, E.14, E.16, E.17, E.18,

E.20, E.21, E.22, E.25, E.27
Robert Bos, Geneva
E.23, E.24.

E.1 View of a varied catchment topography and vegetation in the Philippines

Slide E.1 View of a varied catchment topography and vegetation in the Philippines

E.2 Forest clearing in Thailand

Slide E.2 Forest clearing in Thailand

E.3 Forest clearing and shifting cultivation in Thailand

Slide E.3 Forest clearing and shifting cultivation in Thailand

The pristine environment of primary forests in tropical areas harbours a great deal of biodiversity. Among the insect species present there may be those of medical

importance, but their densities are usually low. Research by Amerasinghe *et al.* in Sri Lanka (System C of the Mahaweli Development Project) has shown how habitat simplification, occurring when a forest area is developed for irrigated agriculture, can favour important vector species, in the Sri Lanka case *Anopheles culicifacies.*

The current trend to consider the development and management of catchment areas (slide E.1) and river basins in an integral manner, spearheaded by the World Bank, offers new opportunities to incorporate environmental management measures for disease vector control. Where dams are built in a river basin, reservoir fluctuation, down-stream artificial floods and salt water intrusion at the estuary may be employed to reduce vector-borne disease risks. In international river basins, such measures may be hampered by the difficulties of establishing effective institutional arrangements needed for this type of integrated management.

Those involved in forest clearing and shifting cultivation in Thailand are at a great risk of malaria infection. This type of cultivation is often practiced by hill tribes in northern Thailand to grow opium. In Colombia, a similar situation exists in the tropical forest areas where so-called informal agriculture (i.e. the cultivation of coca) occurs, closely associated with intense transmission foci.

The association between deforestation and malaria incidence varies in different parts of the world. Deforestation in West Africa led to a replacement of *Anopheles funestus* populations by *Anopheles gambiae* populations, and to a sharp increase in incidence. In Malaysia, deforestation favoured the principal malaria vector *Anopheles maculatus,* which prefers slow-moving, sunlit stream.

In the forested areas starting west at the Chittagong Hill Tracts in Bangladesh, throughout Myanmar, Thailand, Cambodia and Lao PR, as well as on some of the islands of Indonesia and the Philippines, mosquitoes of the *Anopheles dirus* group are the main malaria vectors. In man-made environments that mimick the forest ecology (rubber plantations) transmission by the same vector occurs.

E.4 Rice cultivation following deforestation

Slide E.4 Rice cultivation following deforestation

Populations resettled in recently deforested areas suffer the double risks of the forest fringe. Rice cultivation as shown here in South East Asia carries the risk of Japanese encephalitis outbreaks that occur at intervals when favourable conditions prevail. Such resettled communities often also depend economically on the nearby forest, and will therefore be exposed to malaria transmission by *Anopheles dirus.*

E.5 Shifting cultivation and upland rice in India

Slide E.5 Shifting cultivation and upland rice in India

E.6 Shifting cultivation and upland rice in Thailand

Slide E.6 Shifting cultivation and upland rice in Thailand

Forest clearing in upland areas of India (E.5) and Thailand (E.6) show the introduction of cultivation on slopes too steep to provide for sustained crop

production. As top soil and fertility is lost, farmers will move on to new areas, to clear and destroy new land. A continuing cycle of population movement into potentially hazardous areas is thus propagated, without an opportunity to control either resource degradation and health risk.

Down stream in a catchment area where this cycle takes place, rivers carry excessive amounts of silt, which reduce the livespan of reservoirs and dams. In floodplains, the silt deposits may change the local ecology to the extent that breeding of mosquito vectors is significantly promoted.

E.7 Forest workers in South East Asia

Slide E.7 Forest workers in South East Asia

E.8 Camp of collectors of Brazil nuts in the Amazon region

Slide E.8 Camp of collectors of Brazil nuts in the Amazon region

Forest workers often enter the hazardous environment at peak transmission times. The malaria risks of the workers in Thailand (E.7) have already been extensively covered. Their colleagues in Brazil (E.8: a camp of collectors of Brazil nuts in the Amazon region) do not only suffer the risk of malaria but also of muco-cutaneous leishmaniasis, transmitted by sandfly vectors belonging to the genus *Lutzomyia.*

E.9 Cutting firewood near Penang, Malaysia

Slide E.9 Cutting firewood near Penang, Malaysia

E.10 Collecting and transporting wood for the market, Ethiopia

Slide E.10 Collecting and transporting wood for the market, Ethiopia

The collection of fuel wood is a daily occupancy for many people in parts of the world where they have no access to or cannot afford other types of fuel. Fuel wood collectors are another vulnerable group when it comes to forest related

vector-borne disease risks.

E.11 Resin tapping in a pine forest, Viet Nam

Slide E.11 Resin tapping in a pine forest, Viet Nam

E.12 Rubber plantation inter-cropped with pineapple, Thailand

Slide E.12 Rubber plantation inter-cropped with pineapple, Thailand

E.13 Gum tapping in Indonesia

Slide E.13 Gum tapping in Indonesia

Various types of tree plantations will create the level of relative humidity required by some of the forest breeding malaria vectors. The plantation activities often

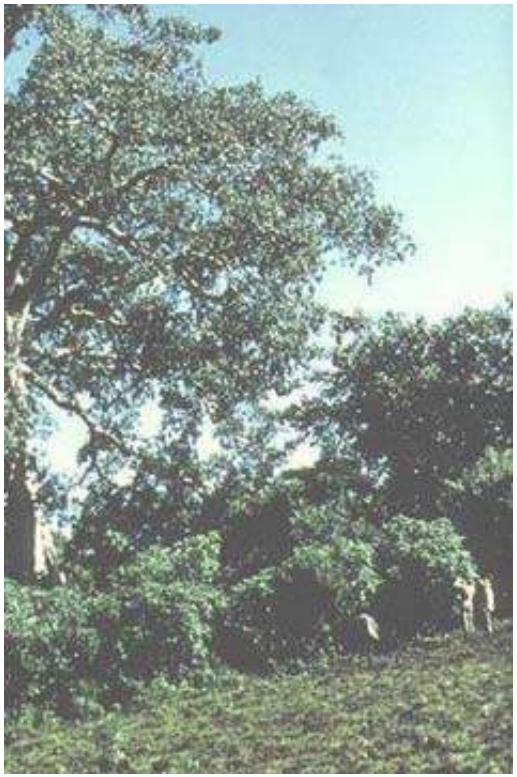
coincide with peak biting times: gum and resin collection is preferably done at night when yields are highest Certain perishable fruits (such as the local salak fruit in Indonesia) are collected at night for marketing first thing in the morning.

Oil palm plantations are associated with malaria, scrub typhus and leptospirosis. The distribution of scrub typhus covers the Indian subcontinent, South East Asia and me Western Pacific. The pathogen, *Rickettsia tsutsugamushi,* is transmitted by trombiculid mites belonging to the genus *Leptotrombidium.* Rodents are important reservoirs, but transovarial transmission also keeps the pathogen in the vector population.

E.14 Coffee picking in Colombia

Slide E.14 Coffee picking in Colombia

E.15 Coffee plantation shaded by figtrees, Ethiopia



Slide E.15 Coffee plantation shaded by figtrees, Ethiopia

Coffee plantations provide an environment which, depending on the local situation, may bring workers into close contact with disease vectors. The choice of the coffee variety and whether or not to have shade trees may have a bearing on the hazards, in particular the sandfly ecology and the epidemiology of leishmaniasis. An additional health hazard, beyond the scope of this slide set but nevertheless worth mentioning, arises from me processing of the berries. The resulting residues with their high organic content can cause serious pollution of local water resources, affecting drinking water supply.

E.16 Fodder collection in India

Slide E.16 Fodder collection in India

Animal fodder collection in forested zones is another occupation which takes members of rural communities into risk areas for vector-borne diseases.

E.17 Coconuts and cattle in Western Samoa

Slide E.17 Coconuts and cattle in Western Samoa

The Pacific island harbour a form of lymphatic filariasis whose transmission takes plays during daytime (as opposed to the nocturnal form transmitted by *Culex quinquefasciatus* elsewhere). The vector is *Aedes polynesiensis.* It breeds in small water collections, with open coconut shells and crab holes contributing significantly to populations densities. Several biological control methods (copepods, fungi) have been tested with initial but not lasting results.

In South India and Sri Lanka, coconut husks undergo a rotting process to release the fibre. Organic material in the coconut husk pits creates a suitable environment for Culex quinquefasciatus and this type of cultivation is therefore closely associated with *Wuchereria bancrofti* filariasis.

E.18 Introducing forestry in areas in India with problems of waterlogging and salinity

Slide E.18 Introducing forestry in areas in India with problems of waterlogging and salinity

One way of dealing with water logging is to plant trees with a high water absorption capacity. This method has been used in various field trials of bio-environmental control of malaria by the Malaria Research Centre in Delhi. This integrated approach includes the use of larvivorous fish and physical improvements aimed to reduce seepage and standing water. Community participation is a hallmark of this approach.

Reference:

Sharma, V.P. (ed.), 1993. *Community participation in malaria control.* Malaria Research Centre, 22 Sham Nath Marg, Delhi 110 054, India

E.19 Pioneer planting in a Brazilian forest with a risk of leishmaniasis transmission

Slide E.19 Pioneer planting in a Brazilian forest with a risk of leishmaniasis transmission

Settlers moving into the Brazilian rainforests come with many objectives. The

health risks they are exposed to go beyond vector borne diseases such as malaria or leishmaniasis. They may range from malnutrition, to sexually transmitted diseases and trauma or death through violence.

Conventional control methods usually have little effect in this pioneer environment, and community based approaches fail in a context where there is frequently very little sense of community to begin with.

E.20 A papaya plantation in Mauritania

Slide E.20 A papaya plantation in Mauritania

E.21 Cassava production in Mozambique

Slide E.21 Cassava production in Mozambique

E.22 Cassava production in Indonesia

Slide E.22 Cassava production in Indonesia

Fortunately there are also crops with little or no vector-borne disease risks such as the papaya and cassava plantations shown in these slides.

E.23 Sugar cane field adjacent to rice paddy in Tamil Nadu, South India

Slide E.23 Sugar cane field adjacent to rice paddy in Tamil Nadu, South India

E.24 Close up of sugar cane crop, Tamil Nadu, South India

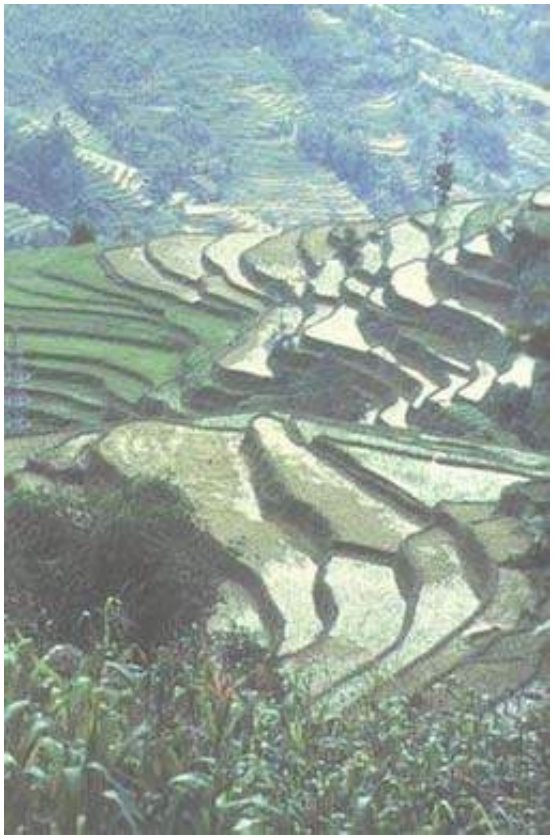
Slide E.24 Close up of sugar cane crop, Tamil Nadu, South India

Farmers' decisions in crop selection are guided by the marketability of their produce. In this traditionally rice growing area of Tamil Nadu, South India, many farmers switch to sugar cane when the price of rice slumps on world markets. Such changes in the cropping system may have unexpected health repercussions. In this particular case, the longevity of rice field breeding mosquitoes may be extended because of the availability of relatively cool, moist resting places in the cane fields.

Cropping patterns can be influenced by governments through financial incentives

(taxation or subsidies) or by imposing import tariffs. In West Africa, for instance, rice consumption by expanding urban populations is rapidly increasing. Governments want to encourage local rice cultivation to save their foreign currency reserves, but to do so they have to instate tariffs on the imports of much cheaper Asian rice to keep local farmers in business. Health implications are seldom considered in such policy decisions; the impact of development policies on health has been the subject of a WHO review (Cooper Weil D.E. *et al.,* see bibliography)

E.25 Terraced rice fields in Nepal



Slide E.25 Terraced rice fields in Nepal

A high level of agricultural skills is needed in Nepal, where only 18% of the total land area is available to support 93% of the population. Vector-borne disease problems, which exist in Nepal, must inevitably be solved within the limitations to feasibility imposed by consideration of cultivation and production. Farming is mainly at subsistence level and per capita income is one of the world's lowest.

On the positive side of things, transmission risks generally decrease at higher altitudes and the bulk of vector-borne disease problems in Nepal are found in the lowlands of the Terai area.

E.26 Lowland irrigated rice in southern Asia

Slide E.26 Lowland irrigated rice in southern Asia

Lowland irrigated rice production in South Asia (Pakistan, India and Nepal) is associated with malaria and Japanese encephalitis. In the Terai area of Nepal,

Anopheles annularis **and** ***A. culicifacies*** **are responsible for malaria transmission.**

In Pakistan, extensive irrigation in the Punjab suffers from high water tables and waterlogging. A massive water management and drainage programme is underway to correct this. Preliminary analysis, using remotely sensed data, indicated that there is a link between the severity of waterlogging and malaria transmission. The impact on health of the drainage projects is therefore expected to be positive.

In the tropics, irrigated, terraced rice cultivation in small plots is often a continuous process, where at any one time, all different stages of the cropping cycle occur. This creates conditions favourable to perennial malaria transmission. In an historic review of the environmental approaches to malaria control in Indonesia (Takken ***et al.*** **see bibliography), the case of the Cihea Plains irrigation development on the island of Java is described After a short period of high productivity, yields went down and many fields remained uncultivated because of high malaria prevalence. After an investigation by malarialogists, improvements in water management and drainage were suggested. In addition, a less orthodox plan to synchronize the cropping cycle was proposed. Even though this met with initial resistance from both the irrigation authorities and the farmers themselves, it was eventually implemented with great success, reducing the transmission period and intensity substantially.**

E.27 Rice field, bush and dwelling, Bali, Indonesia

Slide E.27 Rice field, bush and dwelling, Bali, Indonesia

A diverse rice agro-ecosystem such as this scene from Bali harbours more health hazards than vector-borne diseases alone. Lack of adequate sanitation will promote the prevalence of intestinal helminths, such as *Ascaris,* hookworm and *Trichuris.* Damp conditions inside houses and indoor air pollution from stoves will contribute to respiratory diseases. If communities have no access to safe drinking water, risks of gastro-intestinal infection are high. Zoonoses and rodent-borne diseases may also take their toll and in some irrigated rice areas in Asia and Africa, snakebite as a cause of mortality cannot be neglected.

In a sufficiently balanced ecosystem, however, such disadvantages may gradually disappear as farmers improve their living conditions, invest surplus income partly into community services, and obtain a better access to health services. Health risk reduction and management can greatly accelerate the development process and improve quality of life.