



United Nations  
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# Climate and HIV/AIDS

*A hotspots analysis for Early Warning Rapid Response Systems*



**A Joint Publication of UNDP, FAO and NCAR**





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## **Climate and HIV/AIDS: A hotspots analysis for Early Warning Rapid Response Systems**

**By: René Gommès**  
Senior Agro-meteorologist  
Environment and Natural Resources Service (SDRN)  
Food and Agriculture Organization of the United Nations

**Jacques du Guerny**  
Consultant  
UNDP South East Asia HIV and Development Programme

**Michael H. Glantz**  
Senior Scientist  
Environmental and Societal Impacts Group  
National Center for Atmospheric Research (NCAR)  
Boulder, Colorado, United States of America

**Lee-Nah Hsu**  
Manager  
UNDP South East Asia HIV and Development Programme

**Edited by: Jessica White**  
Intern  
UNDP South East Asia HIV and Development Programme

**Building Regional HIV Resilience**  
UNDP South East Asia HIV and Development Programme

**September 2004**

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Printed in Bangkok, Thailand.

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*Contact information: Lee-Nah Hsu, Manager  
Building Regional HIV Resilience  
UNDP South East Asia HIV and Development Programme  
René Gommès, Senior Agro-meteorologist  
Environment and Natural Resources Service (SDRN)  
Food and Agriculture Organization of the United Nations*

*E-mail addresses: leenah.hsu@undp.org, Rene.Gommès@fao.org*

*Cover design: Vincent Fung, UNDP South East Asia HIV and Development Programme*

#### United Nations ESCAP Library Cataloguing in Publication Data

Climate and HIV/AIDS: A hotspots analysis for Early Warning Rapid Response Systems / By René Gommès, Jacques du Guerny, Michael H. Glantz, Lee-Nah Hsu. Bangkok: UNDP; Rome: FAO; Colorado: NCAR, 2004.

iv; 22 p. (Building Regional HIV Resilience: UNDP South East Asia HIV and Development Programme).

Includes bibliographical references.

ISBN: 974-92327-6-3

1. AIDS. 2. Climate. 3. Agriculture. 4. Environmental Degradation. 5. Adaptation to Change.

UDC: 616.39-907 (100) Gom

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## FOREWORD

Identifying possible interrelations between *climate* and *HIV/AIDS* might seem, at first glance, far fetched.

But is it really so? One might form a different opinion after reading this paper. Sceptics might also think that such topics would have no policy or programmatic relevance. Again, when centred on the concept of *hotspots*, in which climatic factors can play an important role, it begins to be clear that certain aspects of climate are useful within the framework of an Early Warning Rapid Response System (EWRRS) for HIV/AIDS. Thus, early warning systems for HIV/AIDS can produce synergies with other warning systems, for example in agriculture and food security, which can also be climate dependent.

UNDP South East Asia HIV and Development Programme (UNDP-SEAHIV) has published several papers focusing on agriculture and its importance in HIV/AIDS epidemics, both in itself and in the context of rural communities. Following a bad crop, indebted farmers migrate to access other resources or, worse, can be driven to close their eyes on what can happen to their children. Climate factors become important in such a context.

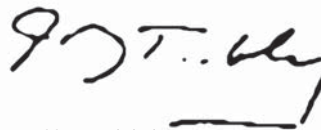
This paper is a first application by FAO's Environment and Natural Resources Service of the hotspots concept to an issue where environment and agriculture play a complex role. It forms a package with another recent paper, *Environment and Agriculture Interactions: Implications for HIV and other infectious diseases*,<sup>1</sup> which examines HIV/AIDS, together with other infectious diseases, within the immediate physical environment of rural communities and households. The two papers form building blocks of the knowledge base of the UNDP-SEAHIV Programme. Furthermore, considering the papers together, as well as in relation to the concept of the Early Warning Rapid Response System,<sup>2</sup> opens new possibilities for interventions which can reinforce and complement the present health efforts and strategies.

This treatment of root causes of HIV vulnerability puts into question traditional frameworks and challenges those in research – as well as those in action – to consider in a more holistic framework HIV/AIDS and other infectious diseases which are related to changes introduced by development.

A word of caution: this paper is very much work in progress, limited to exploring some issues, opening doors onto others. Its main purpose is to encourage readers to join in this investigation of some of the complexities of HIV/AIDS. It is hoped that it will constitute the basis for further exploration of the interrelations between HIV/AIDS and the environment.



Lee-Nah Hsu  
Manager  
Building Regional HIV Resilience  
UNDP South East Asia  
HIV and Development Programme



Jeff Tschirley  
Chief  
Environment and Natural Resources Service  
Food and Agriculture Organization of the  
United Nations

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<sup>1</sup> du Guerny, J., and L.-N. Hsu (2004). *Environment and Agriculture Interactions: Implications for HIV and Other Infectious Diseases*, UNDP South East Asia HIV and Development Programme, July ([http://www.hiv-development.org/publications/env\\_agri.htm](http://www.hiv-development.org/publications/env_agri.htm)).

<sup>2</sup> Guest, P., J. du Guerny, and L.-N. Hsu (2003). *From Early Warning to Development Sector Responses against HIV/AIDS Epidemics*, UNDP South East Asia HIV and Development Programme, May (<http://www.hiv-development.org/publications/EWDSR.htm>). Available in English and Chinese.

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## I. INTRODUCTION<sup>3</sup>

The current profusion of literature on future climate change impacts contains little about HIV/AIDS. For instance, the authoritative report by WHO/WMO/UNEP (2003) only mentions that there is, currently, an apparent increase in many infectious diseases, including some newly circulating ones (HIV/AIDS, Hantavirus, hepatitis C, SARS, etc.). The report indicates that the increase reflects the combined impacts of rapid demographic, environmental, social, technological and other changes in our ways of living. A second recent UN report (Kovats *et al.*, 2003) just mentions AIDS as a background factor in current mortality. Similarly, two recent UNAIDS reports (UNAIDS, 2002; UNAIDS/WHO, 2003) have hardly any mention of climate or weather, though drought is listed twice in the first.

The transmission of HIV from person to person through sexual contact or other means (mother to child, blood transmission, sharing syringes used for injectable drugs) may be climate independent.

According to the WHO report, *Climate Change and Human Health* (McMichael *et al.*, 1996), health sciences are not well adapted for the analysis of disease causation involving combinations of environmental factors that interact with one another, or influence feedback loops, and that are themselves part of complex systems influenced by human interventions.

Whatever the reasons may be for the near absence of HIV/AIDS in the climate change impacts literature, many of the factors which, according to McMichael *et al.* (2003) and Racaniello (2004) contribute to the emergence of new infectious diseases, are linked very directly or indirectly to climate. They include:

- environmental changes including deforestation, habitat loss and fragmentation, flooding, drought, food shortage, and changes in water ecosystems;
- socio-economic changes including conflict, overcrowding in cities with poor sanitation, urban decay, population growth and the increasing mobility of the world's population, as well as the resulting changes in human behaviour: sex, drug use, travel, diet, and recreation;
- health care (organ transplantation, widespread use of antibiotics, shortcomings of the health infrastructure);
- unsanitary food preparation, globalization of food supplies, changes in food processing, and food insecurity in general;
- microbial adaptation and change, drug resistance, changes in virulence, exposure of humans to disease vectors and reservoirs, and ecological changes that alter the composition and size of insect vectors and animal reservoirs.

Not all of these are dependent on climate nor do they all apply to HIV. Those that do apply are increasing growth and mobility of the world's population, overcrowding in city settlements and households with poor sanitation and, it will be argued in this paper, ecological changes

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<sup>3</sup> The authors wish to thank Michele Bernardi, Stephen Cofield, Stefano Mazzilli and Jeff Tschirley for their critical comments and valuable suggestions to the draft of this paper.

in general. Many of those specific conditions, in particular high population densities and migrations, are directly or indirectly affected by climate and weather.<sup>4</sup>

This paper has three main objectives:

- (1) To show that background vulnerabilities that create the conditions for increasing the risk of HIV infection can be directly or indirectly influenced by climate factors. Certain aspects of climate and weather, as will be shown in the case of Rwanda, can be included in an early warning system, because they could give *even earlier alerts* for crisis building;
- (2) To present key concepts in order to achieve the previous objective, taking into account that some readers may not be familiar with climate issues. The reader is guided through these concepts by using the approach of hotspots. This is a dynamic approach developed for agriculture and other early warning systems: they are thus congruent with the Early Warning Rapid Response System for HIV/AIDS;
- (3) To encourage further exploration of the ideas and concepts presented. Relationships between climate and HIV/AIDS are largely conjectural at this stage rather than empirical. Thus, in order to situate it within a constellation of relations, HIV/AIDS is discussed in a wide open manner along with other issues and human diseases.<sup>5</sup>

The second chapter of this paper briefly outlines the Early Warning Rapid Response System (EWRRS) and formally describes the concept of hotspots. Hotspots analysis refers to such notions as vulnerability, sustainability and environmental thresholds. It suggests a framework to illustrate how very critical environmental situations can imperceptibly develop and affect human sectors and activities well beyond the environment, for instance health as well as politics at all levels of social organization.

The third chapter puts forth the concept of the ‘agri-environmental complex’, showing the fact that environmental variables are closely linked so that it is difficult to modify one without affecting several others.

The fourth chapter shows that agricultural production potential, land degradation (both highly climate dependent), population, and health in general are all closely interrelated.

The fifth chapter focuses on relations between climate variability and human diseases. Chronically poor environmental conditions (e.g. environmental degradation) or acute environmental stress (extreme factors) create conditions that are conducive to the development of diseases, the spread of infectious diseases through migration, food shortages and, most relevant for the case of HIV/AIDS, forcing people to increase their mobility or engage in risky behaviours or activities for survival which they would otherwise not have engaged in.

Conclusions are presented in the last section.

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<sup>4</sup> Climate and weather are related but different concepts. They both apply to a specific location or area. Weather is the *instantaneous* condition of the atmosphere at a specific time, as in the statement ‘it rained yesterday morning’. Climate describes average weather conditions, i.e. the atmospheric conditions that normally prevail. An example of a climatic statement would be: ‘Southern Thailand experiences stable non-freezing temperatures throughout the year’. The main climate resources are solar energy, heat, water, wind etc. They are measured by climate variables, such as sunshine (for solar radiation), rainfall and air moisture (two forms of water), temperature (sensible heat), wind, day length, and many others. The word *meteotropic* is used for conditions that are weather dependent, for instance *meteotropic diseases*. The sciences that study the impact of climate and weather on organisms include biometeorology and agroclimatology among others. It is stressed that weather factors are part of the environment (the atmospheric environment).

<sup>5</sup> This is congruent with the fact that programme interventions on background development factors of HIV vulnerabilities require holistic strategies and multidisciplinary partnership.



## II. KEY CONCEPTS

### 1. Early Warning Rapid Response System (EWRRS)

Strategies designed to combat the spread of HIV/AIDS have been developed under a health paradigm focusing on prevention efforts to reduce the risk of infection (blood products, clean needles and safer sex), care and mitigation of the effects of infection on the infected person, family and community. HIV prevention efforts have predominantly been reactive rather than preventive in that programming responses are based on the prevalence of already infected cases. This approach relies on the proximate determinant of sero-conversion in particular groups and in geographic locations.

The Early Warning Rapid Response System (EWRRS), developed in May 2000 by UNDP-SEAHIV,<sup>6</sup> examines the development paradigm, focusing on the factors which influence background vulnerabilities conducive to increasing or reducing HIV vulnerabilities. This emerging paradigm does not replace the health approach, but complements it. Using an EWRRS, social system factors that make particular groups and locations vulnerable to HIV can be quickly gathered, analysed and appropriate warnings given so that rapid responses can be made by HIV prevention implementing agencies, governments and NGOs.

Because communities are embedded in their physical environment, a comprehensive warning system must involve interplay between the physical and human environment. The EWRRS model is based on the view that a *shock/intervention* into the community would have an impact on its vulnerability and leads to different adaptation strategies, often through mobility. Besides socio-economic and political shocks communities can face, there are also physical shocks such as droughts or floods. Furthermore, there are physical stressors due to the continuing effect of unfavourable environmental conditions. This paper explores the affects of climate, weather and environmental conditions on vulnerability and the relevance of these physical environmental factors for HIV/AIDS Early Warning Rapid Response Systems.

### 2. Hotspots

The concept of *hotspot* adopted in this paper builds essentially on the approach developed by Glantz (2003). Hotspots are locations where human interactions with the environment are considered to be adverse to the sustainability of an ecosystem and the human activities dependent upon it.<sup>7</sup>

Hotspots are a step along a continuum of environmental change, which Glantz illustrates using a pyramid with a 'natural' environment at the lowest level, followed by (1) 'environmental changes', (2) 'land transformation' and (3) 'critical zones' to

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<sup>6</sup> du Guerny, J. and L.-N. Hsu (2000). *Early Warning Rapid Response System: HIV vulnerability caused by mobility related to development*, UNDP South East Asia HIV and Development Project, July (<http://www.hiv-development.org/publications/ewrrs.htm>). Available in English, Chinese, Khmer, Laotian, Thai and Vietnamese; and  
Guest, P., J. du Guerny and L.-N. Hsu (2003), *From early warning to development sector responses against HIV/AIDS epidemics*, UNDP South East Asia HIV and Development Programme, May (<http://www.hiv-development.org/publications/EWDSR.htm>). Available in Chinese and English.

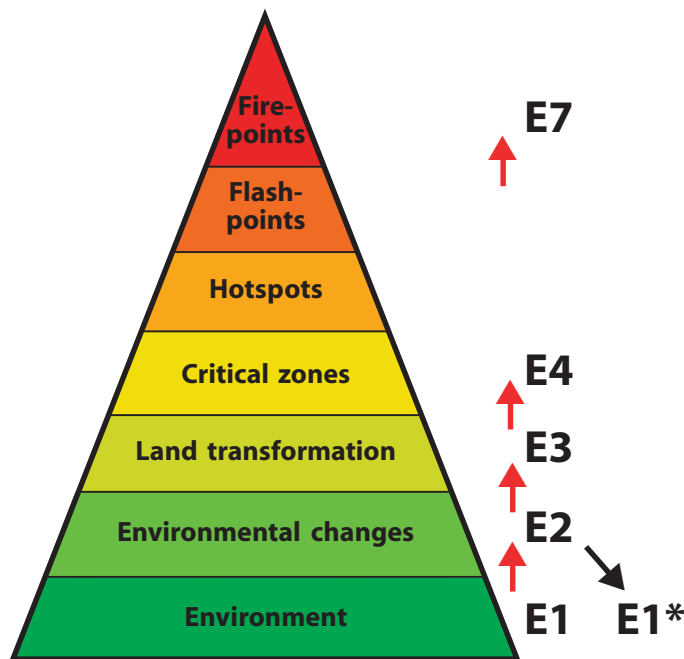
<sup>7</sup> The examples provided here refer mostly to agri-environmental hotspots. The concepts described apply, however, to many other situations. See: Glantz, M.H. (2003). *Guidelines for establishing audits of Agricultural-Environmental (Ag-EN) Hotspots*. FAO Environment and Natural Resource Working Papers No. 15, FAO, Rome (<ftp://ftp.fao.org/docrep/fao/006/y5086E/y5086E00.pdf>).

(4) ‘hotspots’, a critical stage of environmental degradation, irreversible in the absence of human intervention, that can gradually lead to extremely tense socio-economic situations associated with a severe degradation of the environmental resource base.

(1) *Environmental changes*

Environmental changes brought about by human activities (Figure 1: E1→E2), in particular those associated with agriculture, can gradually lead to land transformation, for instance from forest (E1) to various farming systems (E2), from swamp (E1) to drained areas (E2)

**Figure 1: The sequence from environmental changes to hotspots and beyond**



Based on Glantz (2003)

or from dry areas (E1) to irrigated rice production systems (E2). Such changes are usually *neutral*<sup>8</sup> and, to some extent, reversible. This means if the land (E2) is abandoned again, it will spontaneously revert to a system (E1\*) similar<sup>9</sup> to the original *natural* system.

*Spatial scale* is relevant in determining reversibility of environmental change, as a transformation covering just a couple of square kilometres is usually more reversible than a transformation affecting larger areas. In addition to spatial scale, time scale is also useful to describe the duration of which some activity has affected the environment, as well as the time that will be required to revert to system E1\* (which is similar to the original *natural* system E1).

The force (F) applied by human activities or factors further defines environmental change. The absolute value of the factors can be expressed in terms of energy, and is referred to as their *magnitude*. The same factor ‘F’ can have differential impacts depending on the nature of E1 and other variables. The empirical quantitative measure of the changes produced in E1 while being transformed or modified to become E2, is the *intensity*<sup>10</sup> of F.

<sup>8</sup> They are neutral from an environmental point of view: they are neither good nor bad. They just serve the purpose of feeding people or providing them with some other services, for instance recreational fishing or roads.

<sup>9</sup> This term would need defining. How ‘similar’ the secondary system is to the original system depends on the scales.

<sup>10</sup> To make a simple comparison, the 12-point Mercalli scale of earthquake impact is an empirical intensity scale. At the lowest level 0, there is obviously no impact; small objects are displaced at intensity level 5; windows break at intensity 6; chimneys fall at intensity 7; poorly built buildings collapse at intensity 8; bridges are destroyed and broad fissures appear in the ground at intensity 11. On the other hand, the Richter scale is a magnitude scale. For instance, magnitude 4 corresponds to energy of 0.25 Gigajoule. Magnitude 7 corresponds to 40 million Gigajoule. For comparison, the recent Bam earthquake (Iran, 26 December 2003) had a magnitude of 6.6. A rough equivalence between the Mercalli and the Richter scales is possible only for E1 systems with similar vulnerability patterns.

The intensity will be large if the *vulnerability* of E1 is large. The complex relations between *intensity*, *magnitude* and *vulnerability* cannot be discussed in detail here.<sup>11</sup> It is stressed that the concepts described above apply to all levels of the pyramid in Figure 1.

### (2) *Land transformation*

As suggested, the changes associated with the lowest levels of the pyramid are largely neutral, and they are often positive from societal and economic perspectives. More profound changes are described by Glantz as land transformation (E3). No unique definition can be provided, except that transformed land is largely managed by people.

### (3) *Critical zones*

Critical zones (E4) appear if the level of human action sporadically threatens *sustainability*. For example, if people move into a new area (for instance driven by conflict), a drought<sup>12</sup> of a low magnitude or short duration may lead to a critical situation. A drought of the same magnitude would not have created any problem under circumstances of normal vulnerability.

### (4) *Hotspots*

It is the authors' view that sustainability can be regarded as largely equivalent to *adaptability*.<sup>13</sup> A system survives over time if it is able to cope with environmental variability and shocks and if people can adapt to the new circumstances. We can define a hotspot as a 'location' or 'activity' where the adaptation potential of environment and populations is at immediate risk of being exceeded. In this view, hotspots are seen as *pivotal* in the sequence of changes: they are the last stage at which prevention is still useful and relatively less costly; afterwards, the types, costs and benefits of interventions change in nature to focus on damage control, mitigation of impacts, emergency and crisis. Of course, it is preferable and less costly to intervene in the lower strata of the pyramid, but although it might be sound policy according to the saying 'to govern is to foresee', it does not grab headlines! Most environmental processes or development activities fall into the category of 'creeping environmental problems'. That is, the problem is low grade, long term and cumulative.

The definition of *thresholds* is central to hotspots monitoring and analysis. According to Haberle and Chepstow-Lusty (2000), there exist environmental thresholds beyond which adaptability of human societies is exceeded financially, technologically or perceptually. The thresholds may be variability thresholds (extreme factors) or a range of interrelated factors including population growth; conflict over resources; extinctions; environmental degradation; severe epidemics; massive population movements of humans, animals or insects; expanding exchange networks; and increased inter-community warfare. Synthetic *indicators* can describe the resources and other system state variables. For a detailed analysis of monitoring and warning systems in general, refer to Glantz (2004).

The subsequent steps in the hotspots pyramid ('flashpoints' and 'fire-points') describe extremely dynamic run-away situations where environmental problems can contribute to instability in governments, economies and affect areas well beyond the location of the original hotspots.

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<sup>11</sup> The interested reader is referred to Borgia *et al.* (2004) for a systematic and quantitative analysis that applies, *mutatis mutandis*, to the current case as well.

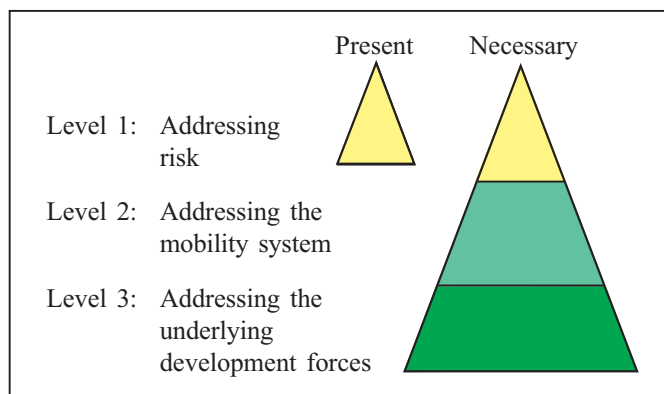
<sup>12</sup> Wet periods and dry periods (runs of days, weeks, months, years) are a manifestation of climate variability.

<sup>13</sup> Boyden (1992) notes that organisms adapt to the new conditions through (a) evolutionary adaptation, (b) innate adaptation (physiological, behavioural) and (c) learning.

### 3. Hotspots and HIV/AIDS Strategies Pyramids: Parallel processes?

The obvious similarity between Figure 1, the Glantz pyramid, and Figure 2, the HIV strategies pyramid (du Guerny, Hsu and Cao, 2003), is not merely a coincidence; it emerges from similar analytical processes focusing on interrelations, on underlying factors and

**Figure 2: HIV/AIDS strategies pyramid: present versus necessary structures of HIV strategies**



Source: du Guerny, Hsu and Cao (2003)

their dynamics. Akin to the ‘hotspots’ stage in the Glantz pyramid, ‘Level 2: Addressing the mobility system’ in Figure 2 could also be considered a pivotal point. Perhaps looking a bit more deeply into such processes can facilitate the dialogues between social and physical sciences as well as provide more effective frameworks for policies and programmes.

‘Hotspot’ has been defined in this paper as a location or activity where the adaptation potential is at risk of being exceeded. This definition can be compared to the mapping of HIV/AIDS hotspots (e.g. Phalla, Leng and Samnang, 2004), which actually

maps the location of brothels, bars, etc.: these are locations where activities can occur under circumstances that fuel HIV.

### III. THE AGRI-ENVIRONMENTAL COMPLEX AS A CONTEXT FOR CHANGE

In spite of the very large spectrum of environmental conditions that exist on earth, such conditions do not, by any means, vary randomly. Climate, for instance, is characterized by an ensemble of variables that behave coherently (the ‘climate complex’), essentially as a result of atmospheric physics and dynamics (Sombroek and Gommès, 1996). For instance, bright sunshine does not normally occur while it rains; rainfall in turn tends to cool the atmosphere because the evaporation of water absorbs heat; cloudy days are characterized by a low daily thermal amplitude (difference between day and night temperature), relatively high air moisture and low evaporation, etc. In addition, the climate at every location has a known ‘usual’ and therefore expected (rightly or wrongly) range of variation.<sup>14</sup>

The ‘climate complex’ is also the basis of agroecological zones (AEZ), interpreted as areas of relative climate stability, associated with typical soils and spectrum of characteristic plants and animals constituting the production system. Agroecological zones can be similarly defined and some authors (Haberle and Chepstow-Lusty, 2000) present evidence that cultural development itself may be linked to environmental conditions. Diamond (1997) has taken this reasoning very far, while permanently warning against any form of geographic determinism.

<sup>14</sup> The climate complex is a set of correlated variables. Some additional information on this aspect and a general overview of climate and agriculture can be found in an unpublished paper by Gommès, R. and L.O. Fresco: *Everybody complains about climate ... What can agricultural science and the CGIAR do about it?* Available at: [http://www.fao.org/livestock/agap/frg/duckweed/cg\\_rev\\_1.doc](http://www.fao.org/livestock/agap/frg/duckweed/cg_rev_1.doc).

To stress the links between all of the environmental and agricultural variables, the AEZ could conveniently be renamed ‘agri-environmental complex’. The link between the elements of the complex is so strong that it can often be described by only one of them. For instance, ‘tropical rainforest’ is sufficient to describe not only a type of vegetation, but also the associated climate, soil types, the characteristics of animals that live in it and a number of features of the lives and livelihood of people living in the forest. The occurrence of a tropical rainforest is conditioned by well-defined macroclimatic conditions, in particular for a wet tropical forest: a humid climate throughout the year with an excess of water and no low temperatures. Inside the forest, the trees themselves affect the conditions, so that species have evolved to be adapted to those microenvironmental conditions that may differ markedly from the regional macroconditions. This observation helps to understand the limited degree of reversibility of changes that affect fragile environments such as wet tropical rainforests.

As indicated in Chapter II, agriculture<sup>15</sup> clearly constitutes the major factor leading to land transformation and, potentially, to hotspots. When describing the emergence of agriculture in various areas worldwide, Diamond (1997) notes that it appeared as ‘packets’ that were adopted as a whole as they spread to other areas. For instance, the Fertile Crescent packet (wheat, barley, peas, lentils, chickpeas, flax, melon), the Chinese packet (rice, foxtail millet, soybean, jute), the Sahelian packet (Sorghum, African millet, African rice, African ground nuts, cotton, cucumbers and *Lagenaria* pumpkins), and the Central American packet (maize, beans, cotton, sisal, etc.). The actual packets include more species than those mentioned here.<sup>16</sup>

The species of the packets, which also include domestic animals at a later stage, evolved in the same geographic area, under rather well defined environmental conditions. Every species is adapted to a specific ecological niche. Its characteristics (structural, physiological and behavioural) result from natural selection. If an organism is removed from its habitat, or if the environment changes, the organism is less well adapted to the new conditions.<sup>17</sup> This is the case not only on land but also in the sea.

In the discussion on hotspots, some emphasis is put on the relatively benign man-made modifications of the environment, i.e. the lowest levels of the pyramid: environment, environmental changes and land transformation. The point is that not all changes to the environment are viewed as adverse from a societal or environmental standpoint. However, when looking at this issue from the point of view of the agro-environmental complex, it is clear that changes affecting one of the variables are likely to have repercussions on many other variables. There are indeed few completely benign man-made transformations.

The important point in this discussion is that typical assemblages of environmental conditions exist, and that they are affected by patterns and paths of degradation (marked by hotspots) that are specific and therefore, predictable to some extent. By analogy to diseases, the word *syndrome* has been used in global change studies to describe environmental hotspots in association with their socio-economic context or causes (Lüdeke, M.K.B *et al.*, 2004).

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<sup>15</sup> FAO includes crop agriculture, animal husbandry, forestry and fisheries in this term.

<sup>16</sup> The ones indicated have been chosen to stress that they all include at least one cereal, one legume, a fibre crop, usually a pumpkin family member, and others.

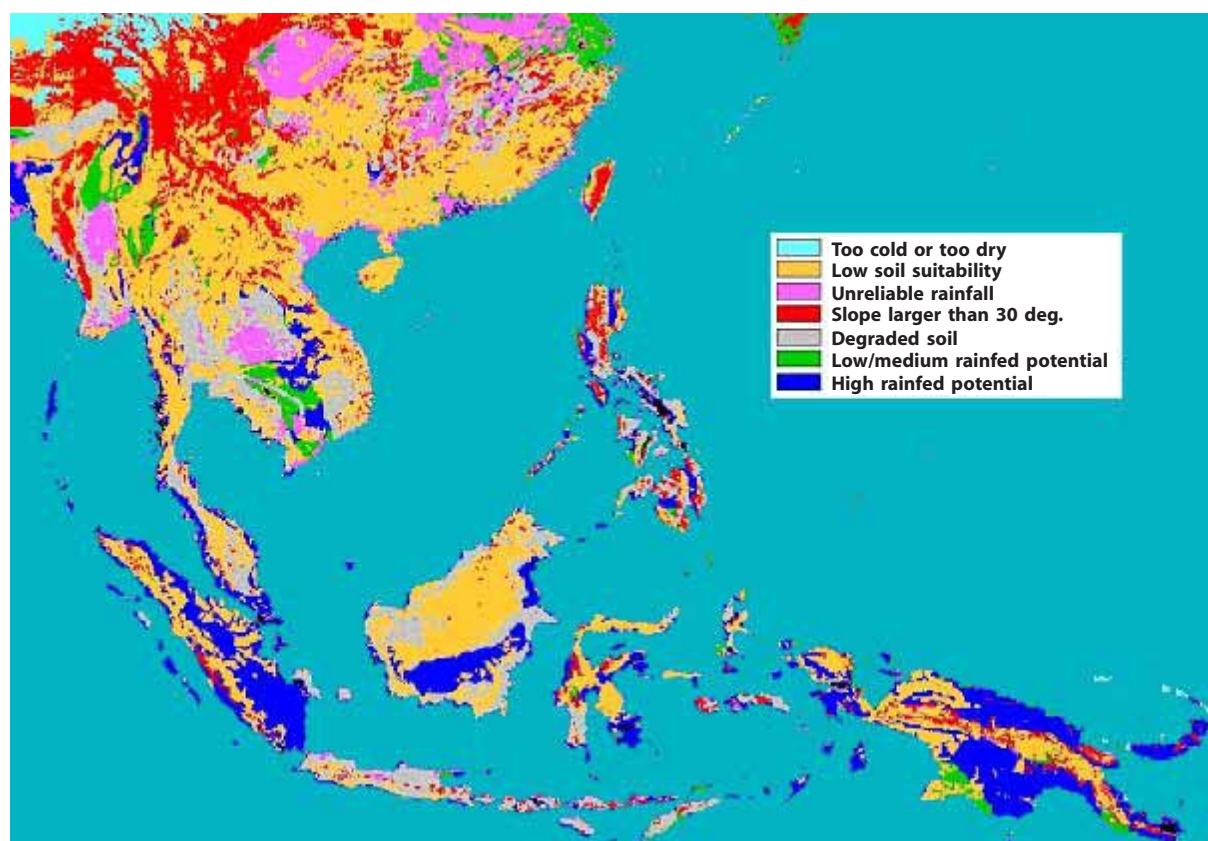
<sup>17</sup> This phylogenetic maladjustment is referred to as ‘evodeviation’ (also ‘evodeviant’) (Boyden, 1992). Boyden extends the concept to all organisms and examines the life conditions that are conducive to health in *Homo sapiens* in a table of ‘universal health needs of humans’.



#### IV. CLIMATE AS A FACTOR IN AGRICULTURAL PRODUCTION POTENTIAL, POPULATION DENSITY AND ENVIRONMENTAL DEGRADATION

The ultimate source of energy for plant growth is solar radiation. The extent to which plants can make use of solar energy is given by water availability. The combination of sunshine and water thus largely conditions the agricultural production potential, together with several other important factors such as soils and the management practices of farmers. The maximum amount of biomass<sup>18</sup> that can be produced at any location with the best practices, taking into account the environmental resources of soil and climate available to a region, is the agricultural production potential, sometimes referred to as *potential production*.

Figure 3: Major limiting factors to agricultural crop production in South-East Asia\*



\* Indicated by colour are areas that are, without intervention, too cold or too dry to be used; those with unsuitable soils; those with unreliable rainfall; locations that are on very steep terrain; as well as severely degraded regions.

Source: FAO (1999)

<sup>18</sup> Biomass is used here to generalize the concept of production that applies to crops, livestock, fish, textile fibre, wood and other useful products derived from agriculture. Plant biomass is expressed in kilogram of dry matter per square metre.



In practice, many factors contribute to reducing potential production. For instance, the slope of the land may be too steep to enable manual or mechanical cultivation without considerable modification of the land (e.g. terracing). A world map of potential production thus shows very large differences. Figure 3 shows major limiting factors to rainfed agriculture in South-East Asia, i.e. factors that set the local limit to farming activities in the absence of irrigation. Clearly, shortages of land and water are to be considered as well for irrigated agriculture.

Quite obviously, after the invention of agriculture, which significantly produced more food than earlier systems (e.g., hunting and gathering), it appears that human populations have quickly tended to multiply in areas with high production potentials. Since epidemics tend to die out in small populations (below 500,000 people), relatively numerous agricultural populations were a great opportunity for diseases, and the development of cities even more so (Diamond, 1997).

Dense populations and fast growth rates in high potential areas are very often paralleled by the degradation of the environment. We thus have the paradoxical situation of some high potential areas being at the same time those with eroded soils, reduced biodiversity, degraded vegetation, etc. Diamond (1997) notes that some of the areas where agriculture originated (independently) are, today, semi-arid or ecological disaster areas such as Iraq, Iran, Mexico, the Andes and the Sahel.<sup>19</sup> The effective role of man in the process is, however, still largely open to debate in several of these locations (Nicholson *et al.*, 1998).

*Linkages between human diseases and the domestication of animals*

The domestication of animals, the subsequent step after the domestication of plants, has helped man increase production and population growth in four different ways: through milk, meat, fertilizer and draught animals (Diamond, 1997). It is less well known that it has also constituted a major source of human diseases.

**Table 1: Examples of human infectious diseases of animal origin**

Disease	Pathogen	Animal source	Date of crossover
Malaria	parasite	chimpanzee	ca. 8000 BCE*
Measles	virus	sheep or goat	ca. 6000 BCE
Smallpox	virus	ruminant?	Before 2000 BCE
Tuberculosis	mycobacterium	ruminant?	Before 1000 BCE
Typhus	rickettsia	rodent	430 BCE & 1492 CE
Plague	bacterium	rodent	541, 1347 & 1665 CE
Dengue	virus	monkey	ca. 1000 CE
Yellow fever	virus	monkey	1641 CE
Spanish flu	virus	bird, pig	1918 CE
AIDS/HIV-1	virus	chimpanzee	ca. 1931 CE
AIDS/HIV-2	virus	monkey	20th century

\* BCE and CE stand for 'before the current era' and 'current era', respectively.

Source: Weiss (2001)

<sup>19</sup> The same areas often gave origin to Wittfogel's hydraulic societies (1957). The concept has been criticized but remains interesting by its emphasis on the interactions between culture and environment.

The domestic transition, an early farming phase approximately 500 generations ago (Boyden, 1992), led to the close association of human populations with domestic animals, much closer in fact than in hunter-gatherer societies. This proximity between man and domestic animals is the source of many diseases. According to Weiss (2001), 55 per cent of human diseases are of animal origin, and humans share about 300 infections with animals. A short list of diseases of animal origin is given in Table 1.<sup>20</sup>

Diamond points out that the worst killers in human history (smallpox, influenza, tuberculosis, malaria, plague, measles and cholera) all originated in animals. Weiss also stresses that epidemic diseases started very recently in the evolution of both microbes and humans: for two million years we were hunters; for ten thousand years we were farmers. Many common diseases are indeed very recent. For those for which their first occurrence can be dated, Diamond lists smallpox (1600 BCE), mumps (400 BCE), plague (200 BCE), epidemic poliomyelitis (1848) and, of course, HIV/AIDS<sup>21</sup> (1959).

In summary, climate has been playing a major role in the distribution of human populations and their densities as a pull factor as well as a push factor. In addition, many of the recent and novel human diseases can be attributed to changing environmental, farming or food-processing practices (Weiss, 2001). Many high potential areas have in time turned into hotspots.

## V. CLIMATE VARIABILITY, FLUCTUATIONS AND HUMAN DISEASES

### 1. Overview

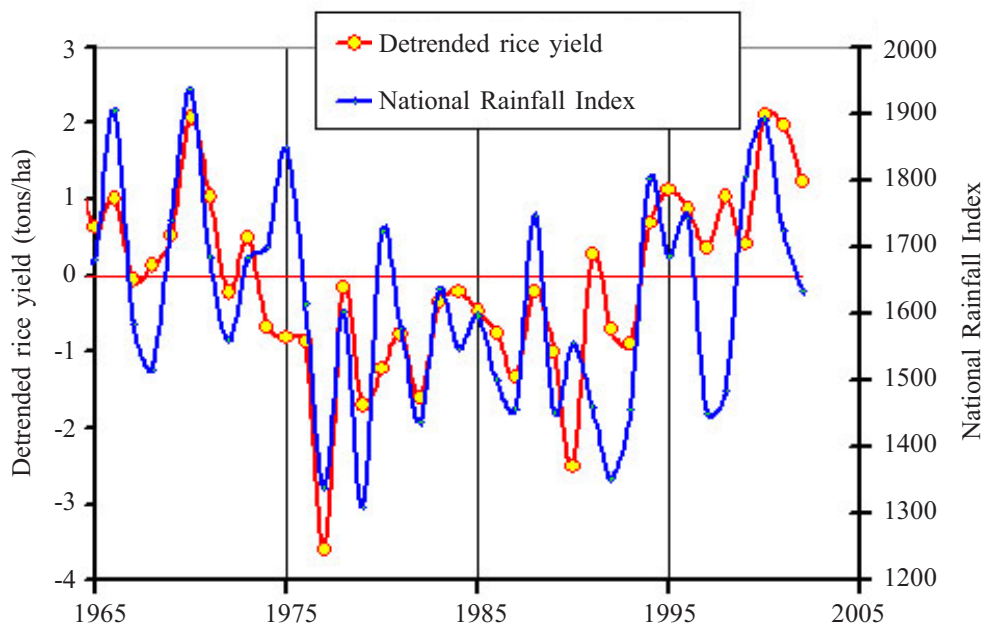
Just as climate is one of the determinants of potential production, and subsequently of high population densities in some areas, weather is one of the main factors behind the inter-annual fluctuations of crop production, even where advanced cropping methods are practised. This is illustrated in Figure 4 in the case of Thailand. After the technology trend has been removed, about 50 per cent of the remaining variability of crop yields can be accounted for by a simple rainfall index.

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<sup>20</sup> The dates provided, especially for antiquity, are rough estimates. For example, Thucydides describes the ‘plague’ in Athens in 430 BCE following the Spartan invasion, which he claims arrived from South of Egypt via the port of Athens. However, medical historians might not be able to properly identify it and thus not take it into account.

<sup>21</sup> To some extent, HIV is a ‘traditional virus’ in the sense that it was transmitted from animal to man, like smallpox, measles and flu. The Chimpanzee *Pan troglodytes troglodytes*, which is native to the central African forests, was probably the origin as the primate harbours the simian immunodeficiency virus which is related to HIV-1 (Racaniello, 2004). In addition, HIV-1 group M exhibits the greatest gene diversity in the Democratic Republic of the Congo, suggesting that it first flowered there (Weiss, 2001).

**Figure 4: Rice yield\* in Thailand compared with a National Rainfall Index (NRI)**



\* The yield is detrended, i.e. the technology component, which accounts for 89 per cent of the variance in yields, has been removed. For details about the NRI, see Gomme and Petrassi (1994). Based on FAO statistics

The literature abounds with examples showing how unusual, anomalous or extreme weather conditions have led directly and indirectly (through destructive crop pests and diseases) to human malnutrition and in turn to health problems, or to both at the same time. An interesting example from British climatologist, Hubert Lamb (1982), is the conditions triggered by the April 1815 eruption of the Indonesian volcano Tambora on Sumbawa. Colossal amounts of dust were injected into the atmosphere,<sup>22</sup> which resulted in reduced sunshine reaching the lower atmosphere. Temperatures dropped by as much as 10°C in the northern hemisphere during 1816, a year widely known as ‘the year without a summer’ (Stothers, 1984; Zeilinga de Boer and Sanders, 2002). In comparison, the global effects of the eruption of Mount Pinatubo in June 1991 were felt for two years and included a drop of temperature of about 0.8°C (McCormick *et al.*, 1995).

Lamb (1982) further writes that the ‘first modern pandemic of cholera’ began in Bengal in 1816-1817, at the same time as ‘the most extensive typhus pandemic in European history’, while ‘an epidemic of plague raged in the Balkans’. This may be a coincidence, but it must be stressed that in 1816 and 1817 crops were poor throughout the northern hemisphere. Literally every local European chronicle mentions the years 1816 and 1817 as years of food shortage, famine or disease. For instance, Conrads (1938) describes the

<sup>22</sup> Volcanologists use the Volcanic Explosivity Index (VEI) to describe the *magnitude* of eruptions. It is based mainly on the volume of explosion and the height of the eruption cloud. Tambora, with a Volcanic Eruption Index of 7 is the second largest known VEI. The amount of dust amounted to at least 30 times the volume emitted by the eruption of Mount St. Helens in 1980. The largest known volcanic eruption (Mt. Toba, Indonesia, around 75,000 years ago, with a VEI of 8) may well have been the factor behind the likely reduction of human population between 70,000 and 80,000 years ago, creating an ‘evolutionary bottleneck’ dated independently by DNA studies (Zeilinga de Boer and Sanders, 2002).

situation in Lammersdorf, Germany, during the spring of 1817 as ‘instead of harvesting grass, nettles, clover and other herbs for cattle, they were cooked and mashed to feed hungry families. Hunger forced many people to emigrate’. High food prices and shortage of seeds, which carry over the famine into the next year, are also regularly mentioned.

Lamb (1982) argues that the mechanisms for the great disease outbreaks were, and apparently still are, the following:

- (1) events, such as droughts or floods, that cause the breakdown of sanitation and hygiene;
- (2) weather conditions conducive to the breeding of vectors; and
- (3) weather conditions and many weather-related failures of food production.

Needless to say, food shortages are typically associated with high prices and a number of socio-economic conditions – as cause or effect – that often perpetuate the poverty cycle (Sen, 1981).

The influence of weather and climate on infectious diseases is a very complex problem, especially for extreme weather conditions:<sup>23</sup> a first set of factors lowers the resistance of the human body to infection; a second affects the ease of spread of an infection (Tromp, 1980). For example, Paul Epstein (1993) hypothesized that the El Niño that began in 1991 sparked the 1991-1992 cholera pandemic in South America.

Regarding the first set of factors, we observe that the body’s general resistance to infections can be affected indirectly by the meteorological environment and by seasonal changes in diet.<sup>24</sup> The second set of factors is more complex as it encompasses (1) the influence of weather on social habits (crowding in rooms, refugee camps), (2) its influence on the development (physiology) of micro-organisms and (3) its effect on the spread of the agents via the atmosphere and in water.<sup>25</sup>

In fact, populations with reduced immune responses due to food shortages or other factors such as poor nutrition offer an opportunity to a number of microbes that, under ordinary circumstances are poorly adapted for human infection, to become well adjusted, first to the immunodeficient host (as opportunistic infections) and eventually to immunocompetent humans (Weiss, 2001).

There are several climate-related mechanisms that can result in food crises deepening over several years (Gommes, 1992 and 1998). This is associated with a spatial spread of the food insecurity situation. In hotspots terms, we clearly move up the pyramid at the same time as its spatial extension increases at the lower level.

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<sup>23</sup> Extreme weather conditions refer to conditions that occur infrequently. The public often understands *extreme* conditions to refer to high energy or *violent* situations, as in tropical cyclones, large-scale floods, etc. Of course, an intense cyclone may indeed be *extreme*, but not more so than a drought that occurs after a hundred years of sufficient and reliable rainfall. On the other hand, there is no drought in the Sahara (although there is aridity), as it is usual for the Sahara to be rainless.

<sup>24</sup> Mention should be made of the diseases that eventually affect HIV/AIDS patients, for instance pneumonia. These opportunistic infections may clearly be metatropic in the strict sense, unlike AIDS.

<sup>25</sup> For example, see: Colwell, R.R. (1996). “Global climate and infectious diseases: the cholera paradigm.” *Science* 274: 2025-2031.

**Table 2: A comparison of HIV/AIDS prevalence and food aid requirements of Southern African countries at the end of 2002**

Country	% Adults living with HIV*	% Population in need of food aid**
Angola	5.5%	15%***
Lesotho	31.0%	30%
Malawi	15.0%	29%
Mozambique	13.0%	3%
Swaziland	33.4%	24%
Zambia	21.5%	26%
Zimbabwe	33.7%	49%

\* Report on the global HIV/AIDS epidemic 2002, UNAIDS, July 2002

\*\* Regional food security assessments, SADC-FANR, 16 Sept 2002

\*\*\* This is an estimate; the exact HIV prevalence in Angola is not known, but assumed to be higher than this. Approximately 15 per cent of all Angolans currently depend on external food assistance to survive (UN OCHA, Consolidated Inter-Agency Appeal for Angola 2003, November 2002)

Source: OXFAM (2002)

A situation strikingly similar to some aspects of the great historical epidemics exists in Southern Africa, where the simultaneous occurrence of HIV/AIDS and food insecurity has been nicknamed by some observers as the ‘deadly duo’<sup>26</sup> (Table 2). The factors that contribute to the current situation are given in a report by OXFAM (2002) as a very broad package in which climate is, as usual, present. The package includes erratic rainfall, poor governance, poverty, unsustainable debt burden, failing agricultural policies, unfair international trade regimes, and collapsing public services. The fact that the spectrum covers the whole range from environment to agricultural policies and collapsing public services is a clear sign of an advanced hotspots situation, i.e. the upper levels of the pyramid have been reached.

The OXFAM report stresses that the improvement of the food situation is a prerequisite to reduce the HIV/AIDS pandemic:

“Successful efforts to improve the food security and livelihoods of families should reduce the probability of HIV infection, slow the progression of HIV to AIDS and increase the resilience of households trying to recover from HIV-related illness and death. Proper nutritional support can speed recuperation from HIV-related infections, and allow people living with HIV/AIDS to participate directly in their own care.”

<sup>26</sup> The exact origin of this expression is difficult to trace. A web search finds it in the context of HIV/AIDS and drought (<http://www.worldvision.org>), HIV/AIDS and war (<http://www.alertnet.org>) in the Great Lakes conflict, HIV/AIDS and tuberculosis (<http://www.ifrc.org>), HIV/AIDS and food insecurity (<http://www.reliefweb.int>). The fact that HIV/AIDS is associated with various ‘accomplices’ stresses the focus of this paper that HIV/AIDS must be looked at from various angles, including that of the environment.

The report indicates that in Zimbabwe, maize production on communal farms fell by 54 per cent between 1992 and 1997 because of AIDS-related illness and death. Clearly, at least two more factors played a significant part: high weather variability and the fact that since independence in 1980, but particularly after 1990, the country has been affected by a somewhat disorderly land reform aiming at redistributing part of the land under large-scale farms to smallholders, which disrupted the economy of scale regarding farm size.

Next to high population densities and depressed immune responses due to sporadic as well as chronic malnutrition or disease, the factors that contribute to the establishment of HIV/AIDS hotspots include the movements of people. In fact, mobility is regarded as one of the key factors in determining HIV vulnerability.<sup>27</sup>

## **2. Climate as a factor for mobility**

As shown above, population densities mostly dependent on agriculture are often under the control of the agroclimatic production potential. This refers mostly to permanent settlements. However, large temporary population clusters frequently occur because of war (refugees) or various types of disasters including earthquakes, climate change, and extreme weather events (environmental refugees). Clearly, war does not occur because of climate conditions, but short-term weather extremes can act as a trigger. Environmental refugees, on the other hand, have often been forced off their land by drought or other environmental factors. Needless to say, many population movements are also seasonal (du Guerny *et al.*, 2003). Such nature-induced migrations can lead to the break up of families and to the disruption of social networks, increasing HIV vulnerability.

Differentiating between population movements triggered primarily by environmental factors, and those that are mainly attributable to social, political or economic causes can be difficult. McMichael *et al.* (1996) mention how climate change can lead to increased population movement. The same factors clearly apply to the current as well as to a changed climate:

- (1) temporary displacement due to natural disasters;
- (2) managed or unmanaged retreat from land vulnerable to sea level rise; and
- (3) declining agricultural productivity.

### *(1) Temporary displacement due to natural disasters*

Factors that lead to current natural disasters involve the atmosphere and, therefore, natural disasters need to be mentioned here. However, as most population movements are brought about by normal seasonal changes, their quantitative impact is much larger than the impact of extreme conditions. The migration patterns are known, as are those populations the migrants encounter en route from year to year.

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<sup>27</sup> See: Phalla, T., H.B. Leng and P. Samnang (2004). *Mapping HIV vulnerability along Kampong Thom, Siem Reap, Odor Meanchey and Preah Vihear, Cambodia*. UNDP South East Asia HIV and Development Programme, March ([http://www.hiv-development.org/text/publications/cambodia\\_prip.pdf](http://www.hiv-development.org/text/publications/cambodia_prip.pdf)).



## (2) *Managed or unmanaged retreat from land vulnerable to sea level rise*

Sea level rise can force people to retreat from coastal areas. We currently have limited examples,<sup>28</sup> other than those related to correlated movements of sea and continent which have occurred repeatedly in the distant and in the recent past (Gommes *et al.*, 2004). Of course, there is no reason to limit the causes of retreat from vulnerable land to sea level rise. There are many reasons why populations would leave land that can no longer support them, in a managed or unplanned way.

## (3) *Declining agricultural productivity*

Retreat is unavoidable when the land can no longer sustain the livelihoods of people. This is the somehow paradoxical situation mentioned earlier in this paper where land was overexploited because of its high potential. Not only was land degraded, but *per capita* land availability dropped below the sustainability threshold, a situation which actually threatens a number of countries, including those on small – and not so small – islands:

“The small size of most small island developing states, coupled with land tenure systems, soil types, relief and climatic variation, limit the area available for urban settlement, agriculture, mining, commercial forestry, tourism and other infrastructure, and create intense competition between land use options [...]. As populations grow in small island developing states, there is a need for resolution of competing demands, particularly where land is limited and where commercial development of comparatively large tracts of land can result in shifts in small scale and subsistence agriculture to marginal lands [...]. The major long-term land management issue in small island developing states is the degradation of the limited land area due to a variety of factors, including overuse because of high population pressure on a limited resource base” (from paragraphs 30, 31 and 32, SIDS Programme of Action, 1994).

## **3. The 1994 Rwandan crisis in light of climate variability<sup>29</sup>**

Rwanda, a country with a high population density and high agricultural production potential in the highlands of eastern Africa, provides an illustration of a hotspots situation where a humanitarian crisis, the deterioration of nutrition, and climate variability interact to create a complex humanitarian crisis. The country, about which André and Platteau (1998) use the terms ‘Malthusian trap’, was affected by a genocide in 1994 in which an estimated 1,000,000 people died in 100 days (a recent official government survey put the figure at 937,000 people). About 2,000,000 people were internally displaced or fled to neighbouring countries. The situation eventually directly and indirectly led to a war in

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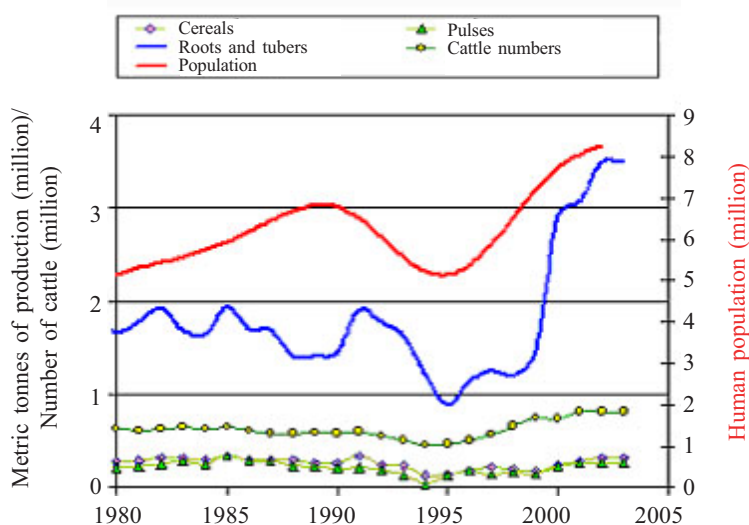
<sup>28</sup> Interestingly, there is an example involving a major fresh water body: the Caspian Sea. The Caspian Sea has been rising rapidly by about 3 metres between 1975 and 1995, affecting Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan. It has been used as an analogue of the broader issue of sea level rise. See [http://www.eia.doe.gov/emeu/cabs/caspenv.html#sea\\_rise](http://www.eia.doe.gov/emeu/cabs/caspenv.html#sea_rise).

<sup>29</sup> Largely based on Gommes (1998) for the climatic aspects.

1998 that involved several countries in the region either as participants in the war effort, or as recipients of refugees, or as both: Angola, Burundi, Democratic Republic of the Congo, Namibia, Tanzania, Uganda and Zimbabwe.<sup>30</sup>

Next to some basic agricultural statistics, Figure 5 shows how the Rwandan population changed in recent years. The fall in population due to the 1994 genocide is quite abrupt.<sup>31</sup> Figure 5 also shows that the production of roots and tubers increased significantly from 1995 after a downward trend until 1994. Cereals and pulses, on the other hand, remained more or less stable. The roots and tubers production curve largely follows the cassava production, which has grown five-fold since 1995.<sup>32</sup>

**Figure 5: Human population and agricultural production in Rwanda 1980-2004**



Based on FAOSTAT

Two important points deserve mention in this context. The first is that the relative increase of cassava in people's diet reflects nutritional deterioration, because cassava is mostly starch-based, with little protein content. The second is that the increase in roots and tubers production constitutes an adaptation to war and to shortage of land, as well as households affected by HIV/AIDS, for the following reasons:

- Cassava performs relatively better than cereals on degraded land;
- Cassava has an undefined phenology. Unlike cereals, cassava can stay in the ground for up to three years, and it can be harvested during any season. Clearly, this is a major advantage in periods of war;

<sup>30</sup> Although Rwanda and the Democratic Republic of the Congo signed a peace agreement in Pretoria in July 2002, it is unlikely that the war will actually end. According to Reliefweb (2003), an estimated total of 3.3 million civilians were killed throughout the Congo, a toll that makes this war more deadly to civilians than any other since World War II.

<sup>31</sup> This could be due to the endless population movements into and out of the country. Particularly in light of the figures announced at the 10th anniversary of the genocide, it is more likely that the figures are inaccurate.

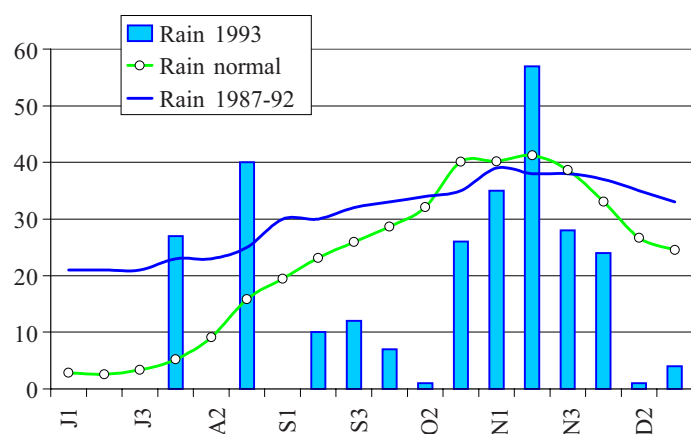
<sup>32</sup> Currently, white potatoes, sweet potatoes and cassava make up approximately one third of the total roots and tuber production, cassava being the most variable of the three that affects the overall behaviour of the curve (based on FAO statistics).

- Cassava out-yields cereals in terms of calories produced per hectare;
- Cassava and other crops that grow in the soil are much less susceptible to degradation by moving troops or people when compared to cereals and beans.<sup>33</sup>

The Rwandan situation is described to illustrate that climatic conditions can play an essential role in triggering and/or aggravating a complex humanitarian crisis. Rwanda is also a country with a high incidence of HIV/AIDS (UNAIDS/WHO, 2003; UNAIDS/WHO, 2002; UNAIDS, 2002), however the exact situation regarding HIV prevalence is difficult to assess because of population movements. The conditions involving HIV/AIDS and war are particularly severe in Rwanda, with the interplay of shortage of resources (e.g. land) and climate variability.

In August 1993, the rainy season started early in Rwanda. However, the September and October rainfalls were low. This shift in rainfall led to a reduction in planted areas, resulting in low yields (see Figure 6). The first bean crop (a major staple) was lost, and could not be replanted due to insufficient rain. In October 1993, a coup in Burundi

**Figure 6: Rainfall conditions in Kigali, capital of Rwanda, July to December 1993**



All variables are measured in litres per square metre.  
Based on data from FAOCLIM, FAO agroclimatic database

was followed by 700,000 people moving, of which 400,000 entered Rwanda. Following the poor harvest prospects and the increased demand for food because of a large influx of refugees, prices soared: the combination of a very unusual drought and population movements created a famine and considerable social tension in March. The genocide erupted in April and May.

It is worth mentioning that the largest and most intense outbreak of cholera ever recorded occurred in Rwanda in 1994, killing over 40,000 people in the space of weeks, in a nation already ravaged

by civil war and ethnic strife. The tragedy of cholera in Rwanda is a reminder of the impacts of conflict and political instability on public health and biological security – just as epidemics may, in turn, contribute to political and economic instability (Epstein, 1997).

A workshop on the possibility of integrating HIV/AIDS prevention in the agriculture reconstruction efforts was held in FAO in 1994, organized by the FAO Focal Point on HIV/AIDS with UNDP participation and support. At that time, the linkages between HIV/AIDS and agriculture were poorly understood and, thus, HIV/AIDS was still perceived as very much outside the concern of the agriculture sector. FAO preferred to concentrate on getting agriculture started again, e.g. by saving seed banks.

<sup>33</sup> Similar reasons were listed for the adoption of white potatoes in Europe after the Napoleonic wars at the beginning of the 19th century.

A joint FAO/WFP mission visited the area in July 1994 and confirmed that a large proportion of fields had been abandoned. Some crops planted in January 1994 were in good condition but no one was there to harvest them. The mission also confirmed that very little land was prepared for the 1994/95 growing season, thereby extending the crisis well beyond 1994. Such a crisis unfortunately also creates favourable conditions for the spread of HIV as has been shown by recent UNAIDS reports (UNAIDS/WHO, 2003; UNAIDS/WHO, 2002; UNAIDS, 2002).

Another workshop on the possibility of integrating HIV prevention in the agriculture reconstruction efforts was held in FAO, organized by the FAO Focal Point on HIV/AIDS with the participation and support of UNDP South East Asia HIV and Development Programme (UNDP-SEAHIV).<sup>34</sup> A subsequent consultation on *African Asian Agriculture against AIDS*, jointly organized by UNDP-SEAHIV and FAO, was held in Bangkok, Thailand.<sup>35</sup> Clear contributions of the agriculture sector in mitigating HIV/AIDS were identified:

- (1) Reviving indigenous knowledge and cultivation of nutritious plants and plant diversities to ensure household food security;
- (2) Cultivating locally available medicinal herbs for symptomatic relief to people living with HIV/AIDS;
- (3) Production of cash crops to supplement income; and
- (4) Labour-saving technologies, mainly for elderly, widows and children in AIDS-affected households.

#### **4. Climate variability as a positive factor**

So far, climate variability has been described mostly as a feature negatively impacting human societies, through increased disease incidence and food shortages.

However, some of the positive aspects of climate and weather variability must not be ignored. For instance, the temperature difference between day and night is essential for plants to store starch. If white potatoes are grown in areas with low thermal amplitude, such as many equatorial coastal areas, they develop abundant foliage, but no potatoes (storage organs). This has been referred to as a 'green drought'.

From a long-term perspective, variability is also an opportunity for evolution. For example, variability stimulates the development of new solutions through adaptation by humans, plants and animals.<sup>36</sup> Temporal and spatial variability is one of the mechanisms through which evolution and innovations are made possible. They constitute natural experiments where some organisms can *take a chance*. In fact, the Intermediate Disturbance Hypothesis (IDH) to explain the origin of biodiversity, proposed by Connell in 1978, has gradually grown into a 'principle', in spite of many efforts to identify exceptions to the rule. The word 'intermediate' refers to 'mild' variations. Very small variations have no consequence, while extreme variations tend to be too destructive.

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<sup>34</sup> December 2001, Rome, Italy.

<sup>35</sup> UNDP, FAO (2004). *African-Asian Agriculture against AIDS*. UNDP South East Asia HIV and Development Programme, April (<http://www.hiv-development.org/publications/5A.htm>).

<sup>36</sup> This is also true for diseases. Our 21st century global village presents a wonderful opportunity should a novel pathogen cross from animals to adapt to human-to-human transmission (Weiss, 2001). This is currently a major fear concerning the potential jump of the Avian Flu Virus from birds-to-human to human-to-human transmission in Asia.

For example, there is good evidence that the shortage of food mentioned in 1816-1817 was one of the factors that finally led to the adoption of Irish potatoes by rural people in northeastern Italy. The fact that extreme events can turn out to be catalysts for innovation is closely related to Haberle and Chepstow-Lusty's (2000) opinion about the role of 'thresholds'. Cipolla (2003) observes in a completely different context that, when they first appear, innovations are less important for their immediate advantages than for their capacity to give rise to future developments, and that this second attribute is always extremely difficult to value.

## VI. CONCLUSIONS

Climate, weather and environmental conditions are relevant for HIV/AIDS Early Warning Systems: they interact with the dynamics of HIV/AIDS because they condition the density of populations, affect their nutrition and health status and often trigger the seasonal or exceptional movements of people.

For each of these aspects, it is necessary to distinguish chronic and acute situations, which in turn are often associated with chronic and acute weather anomalies. The chronic situation relates to the natural variability of climate and weather at daily, monthly, seasonal and inter-annual scales, while the acute situation can be associated with extreme factors.

Although there is little historical depth (time series data) available for HIV/AIDS in comparison with other epidemic diseases, it is clear that the nexus between disease, malnutrition, environmental degradation, and often war, applies. This is to say that the concept of hotspots is relevant to AIDS research, i.e. areas where environmental and associated crises gradually develop into situations that become less and less reversible or less sustainable, whereby adaptability thresholds are exceeded. To some extent, hotspots often follow specific patterns. In recognizing these patterns, there is some potential to predict their occurrence and development, a significant and useful input to HIV/AIDS early warning systems.

By stepping back and placing HIV/AIDS within a broad framework, one becomes aware that despite the specificities of HIV/AIDS, interactions between the environment, agriculture and infectious diseases are interrelated and growing in importance. Strategies aiming at HIV/AIDS background factors and vulnerabilities can also be relevant strategies for other infectious diseases. This leads one to complement existing efforts and advocate looking beyond specific diseases which have been, until now, considered and dealt with in isolation. Are we ready to identify and recognize climate or environmental factors, agricultural practices and change as warning signals for HIV/AIDS and other infectious diseases? If policy makers, programme heads or donors are hesitant to support the exploration of longer term potential health threats resulting from development and environmental changes, they should be aware that effectively harnessing development strategies to pre-empt or mitigate root causes of HIV/AIDS, as well as other infectious diseases, could lead to more sustainable development with high cost-benefit ratios.



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	Climate and HIV/AIDS: A hotspots analysis for Early Warning Rapid Response Systems <a href="http://www.hiv-development.org/publications/climate_HIV.htm">http://www.hiv-development.org/publications/climate_HIV.htm</a> Authors: René Gomme, Jacques du Guerny, Michael H. Glantz and Lee-Nah Hsu A joint publication of UNDP, FAO and NCAR <i>Language: English</i>	974-92327-6-3 September 2004
	Building Regional HIV Resilience along the ASEAN Highway Network <a href="http://www.hiv-development.org/publications/ASEAN_highway.htm">http://www.hiv-development.org/publications/ASEAN_highway.htm</a> Workshop organized by UNDP-SEAHIV, ASEAN Secretariat and World Vision International A joint publication of UNDP-SEAHIV, ASEAN Secretariat and World Vision International <i>Language: English</i>	974-92241-7-5 August 2004
	Environment and Agriculture Interactions: Implications for HIV and other infectious diseases <a href="http://www.hiv-development.org/publications/env_agri.htm">http://www.hiv-development.org/publications/env_agri.htm</a> Authors: Jacques du Guerny and Lee-Nah Hsu <i>Language: English</i>	974-92097-8-8 July 2004
	Plant Diversity, Sustainable Rural Livelihoods and the HIV/AIDS Crisis* <a href="http://www.hiv-development.org/publications/plant_diversity.htm">http://www.hiv-development.org/publications/plant_diversity.htm</a> Author: Josep A. Garí A joint publication of UNDP and FAO <i>Language: English</i>	974-92021-4-7 June 2004
	Mainstreaming HIV Prevention in the Military: A case study from Cambodia* <a href="http://www.hiv-development.org/publications/defense.htm">http://www.hiv-development.org/publications/defense.htm</a> Author: Tan Sokhey Compiled by Allison Woodruff <i>Language: English</i>	974-91992-4-3 May 2004
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	Mapping HIV Vulnerability along Kampong Thom, Siem Reap, Odor Meanchey and Preah Vihear, Cambodia* <a href="http://www.hiv-development.org/publications/cambodia_prip.htm">http://www.hiv-development.org/publications/cambodia_prip.htm</a> Authors: Tia Phalla, Hor Bun Leng, Po Samnang <i>Language: English</i>	974-91403-2-X March 2004
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	<p>Population Movement and HIV/AIDS: The case of Ruili, Yunnan, China*  <a href="http://www.hiv-development.org/publications/Ruili_Model.htm">http://www.hiv-development.org/publications/Ruili_Model.htm</a>            Authors: Jacques du Guerny, Lee-Nah Hsu and Cao Hong            A joint publication of UNDP and CIDA  <i>Languages: English, Chinese</i></p>	<p>974-91669-7-3            August 2003</p>
	<p>From Early Warning to Development Sector Responses against HIV/AIDS Epidemics*  <a href="http://www.hiv-development.org/publications/EWDSR.htm">http://www.hiv-development.org/publications/EWDSR.htm</a>            Authors: Philip Guest, Jacques du Guerny and Lee-Nah Hsu  <i>Languages: English, Chinese</i></p>	<p>974-91330-6-4            May 2003</p>
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	<p>Brunei, Indonesia, Malaysia, Philippines, Singapore Cluster Country Consultation on Migrant Workers' HIV Vulnerability Reduction: Pre-departure, post-arrival and returnee reintegration*  <a href="http://www.hiv-development.org/publications/BIMPS-Report.htm">http://www.hiv-development.org/publications/BIMPS-Report.htm</a>            Workshop organized by UNDP-SEAHIV, CHASPPAR, MOH Philippines, OWWA Philippines and ASEAN Secretariat  <i>Languages: English, Chinese</i></p>	<p>974-680-221-6            September 2002</p>
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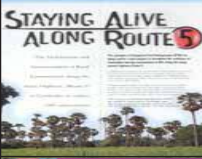


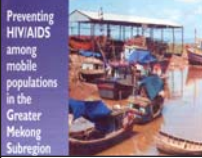

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	<p>ASEAN Workshop on Population Movement and HIV Vulnerability*  <a href="http://www.hiv-development.org/publications/ASEAN_workshop.htm">http://www.hiv-development.org/publications/ASEAN_workshop.htm</a>            Workshop organized by MOPH Thailand, UNDP-SEAHIV, WHO, ASEAN Secretariat, FHI/USAID and SEAMEO-GTZ-CHASPPAR            A joint publication of UNDP-SEAHIV, Ministry of Public Health (Thailand), ASEAN, WHO, FHI, USAID, GTZ and SEAMEO  <i>Language: English</i></p>	974-87637-8-1 June 2000
	<p>Reduction of HIV Vulnerability within the Land Transport Sector: Towards a public policy framework for addressing HIV/AIDS in the transport sector*  <a href="http://www.hiv-development.org/publications/land-transport.htm">http://www.hiv-development.org/publications/land-transport.htm</a>            Workshop organized by UNDP-SEAHIV, UNESCAP and UNAIDS            A joint publication of UNDP/UNOPS, UNAIDS, and UNESCAP  <i>Languages: English, Khmer</i></p>	974-68500-8-3 May 2000
	<p>Population Mobility in Asia: Implications for HIV/AIDS action programme*  <a href="http://www.hiv-development.org/publications/mobility-action-programmes.htm">http://www.hiv-development.org/publications/mobility-action-programmes.htm</a>            Authors: Lee-Nah Hsu, Jacques du Guerny, Promboon Panitchpakdi, Manit Koedkan, et al.            A joint publication of UNDP, UNAIDS, and ICAAP  <i>Language: English</i></p>	974-85835-3-8 April 2000
	<p>HIV Vulnerability and Population Mobility in the Northern Provinces of the Lao People's Democratic Republic*  <a href="http://www.hiv-development.org/publications/Vulnerability-Lao.htm">http://www.hiv-development.org/publications/Vulnerability-Lao.htm</a>            Author: James R. Chamberlain  <i>Languages: English, Laotian</i></p>	974-85913-8-7 March 2000
	<p>Population Mobility and HIV Vulnerability in South East Asia: An assessment and analysis*  <a href="http://www.hiv-development.org/publications/sea_publications_papers.asp">http://www.hiv-development.org/publications/sea_publications_papers.asp</a>            Author: Ronald Skeldon            A joint publication of UNDP/UNOPS and FHI  <i>Languages: English, Chinese, Laotian, Vietnamese</i></p>	974-85835-1-1 February 2000
	<p>Cambodia HIV Vulnerability Mapping: Highway One and Five*  <a href="http://www.hiv-development.org/publications/cambodia_mapping.htm">http://www.hiv-development.org/publications/cambodia_mapping.htm</a>            Prepared by National Centre for HIV/AIDS, Dermatology and STD, Cambodia            A joint publication of UNDP/UNOPS and NCHADS  <i>Language: English</i></p>	974-68016-7-8 January 2000

\* These publications are no longer available in hard copy format; however, they may be downloaded in electronic form from the following website: <http://www.hiv-development.org>

## Additional Publications

COVER	TITLE	ISBN DATE
	Crossing national and sectoral boundaries in HIV/AIDS strategies – experiences from South East Asia <a href="http://www.hiv-development.org/text/publications/Crossing_Boundaries.pdf">http://www.hiv-development.org/text/publications/Crossing_Boundaries.pdf</a> Article in Sexual Health Exchange 2003/2 Authors: Lee-Nah Hsu and Jacques du Guerny <i>Language: English</i>	September 2003
	UNESCO/UNDP-SEAHIV/UNAIDS/SMA/CIDA HIV/AIDS: Be safe not sorry Mobilising a Response to HIV/AIDS in the Maritime Industry <i>Course information for instructors, course information for students and CD-ROM course materials</i> <i>Languages: English, Chinese</i>	92-1-120160-8 July 2002
	ADB/UNDP-SEAHIV/WVI/Burnet Institute: Toolkit for HIV prevention among mobile populations in the Greater Mekong Subregion <a href="http://www.hiv-development.org/publications/Tool-Kit.htm">http://www.hiv-development.org/publications/Tool-Kit.htm</a> <i>Languages: English, Chinese, Burmese, Khmer, Laotian, Vietnamese</i>	1-875140-52-2 2002
	Independent Review of the UN Regional Taskforce on Mobile Populations and HIV Vulnerability <a href="http://www.hiv-development.org/text/task/review2001.doc">http://www.hiv-development.org/text/task/review2001.doc</a> Author: Jacques du Guerny <i>Language: English</i>	November 2001
	Strategy on Mobility and HIV Vulnerability Reduction in the Greater Mekong Subregion 2002-2004 <a href="http://www.hiv-development.org/publications/Strategy.htm">http://www.hiv-development.org/publications/Strategy.htm</a> <i>Languages: English, Chinese, Burmese, Khmer, Laotian, Thai, Vietnamese</i>	September 2001
	UNDP-FAO Mobilization and Empowerment of Rural Communities along the Asian Highway (Route 5) in Cambodia to Reduce HIV Vulnerability <a href="http://www.hiv-development.org/publications/review-route5.htm">http://www.hiv-development.org/publications/review-route5.htm</a> <i>Fact sheet and project evaluation report by Jacques du Guerny</i> <i>Languages: English, Khmer</i>	April 2001
	UNIFEM/UNAIDS/UNDP-SEAHIV Information Kit on Women, Gender and HIV/AIDS in East and South East Asia <i>Language: English</i>	March 2001
	Better Safe than Sorry: Preventing HIV/AIDS among mobile populations in the Greater Mekong Subregion <i>Video CD</i> <i>Languages: English, Chinese, Laotian, Vietnamese</i>	2001
	ADB/UNDP/WVI/ARCM: Mobility and HIV/AIDS in the Greater Mekong Subregion <i>Fact sheet, inception report and profiling report</i> <i>Language: English</i>	1-875140-48-4 December 2000
	Regional Summit on Pre-departure, Post-arrival and Reintegration Programmes for Migrant Worker Workshop organized by CARAM Asia, UNDP-SEAHIV, CHRF and IOM <i>Report</i> <i>Language: English</i>	983-40375-0-3 September 2000
	CIPY Heritage Producer: Hem Monirith, Director: Tith Thearith, Assistant Manager: Ouk Sokha Technical assistance: Mean Chhi Vun, Lim Thaipheang, Tia Phalla, Seng Sutwantha, Hor Bunleng and Po Samnang <i>Video CD</i> <i>Languages: Khmer with English subtitles</i>	November 1999



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**ISBN: 974-92327-6-3**