Human Schistosomiasis, And Nigerian Environment And Climate Change

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Definition

Human schistosomiasis, commonly called "bilharziasis" after a German pathologist, Theodor Bilharz (who first discovered the parasitic agent in Egypt in 1851) is caused by parasitic trematode of the genus, *Schistosoma*. There are at least 19 varieties of schistosomes, of which five are pathogenic parasites of man: *S. haematobium, S. mansoni, S.japonicum, S.intercalatum and S.marteei* (WHO, 1985). There are two types of human schistosomiasis in Nigeria: urinary schistosomiasis caused by infection of *S.haematobium* and intestinal schistosomiasis caused by the infection of *S.mansoni*. Different species of freshwater snail which breed in rivers, streams, lakes (both natural and man-made), ditches, paddy field, irrigation, canals etc are the intermediate hosts. The snail intermediate host of *S.haematobium* is *Bulinus* while the intermediate hosts of *S. mansoni* belong to the genus *Biomphalaria*. Human infection occurs when cercariae (that emerged from the nail intermediate hosts) penetrate the skin of man exposed to contaminated water. In man, the clinico-pathological damage caused by schistosomiasis is serious and is related to the reaction of the host tissues to the migrating young worms, the eggs laid by the adult worms, and the number of schistosomes eggs trapped in the tissues. Details of these have been presented by Odeku et al (1968). Makenna et al (1997), Elem (1998), Udonsi (1999), Anosike et al (2002).

Disease Burden and Distribution

In terms of socioeconomic and public health importance in the tropics and subtropical regions, schistosomiasis is second only to malaria. The most current estimates show that 200-300 million people are infected by all forms of schistosomiasis in the world and about 600 million are exposed to the risk of infection, especially among those who perform daily service related to untreated waters, swimming, fishing, irrigated farming, washing and bathing in ponds and streams (Webbe, 1981. WHO, 1990; 1998). The estimate of global symptomatic patients is put at 120 million. The number of severely infected people is at 20 million persons while the mortality rate is estimated to be about 14,000 persons annually. The disease burden is 1.93 million Disability Adjusted life years (DALY) (World Bank, 1993; WHO, 1998). Schistosomiasis is associated with clinical discomfort, physical disability and death, low agricultural productivity and consequent economic loss. Available results show that the disease leads to early incapacitation of young people who constitute the bulk of labour force (Abdel-Salam and Abdel fallab, 1977). The studies of Foster (1967) showed that infected people earn fewer bonuses than the uninfected and the global monetary loss as a result of schistosomiasis was put at $650 million. In addition, evidence of adverse effect of schistosomiasis on mental capability among infected children was recorded by Castile et al (1974). On the social impact, Herrin (1988) reported that infection caused severe and recurrent pain on infected persons and the society looked down on infected men and women. Indeed, "it was thought that an individual infected by *S. haematobium* would damage the social standing of his family".

Of all the parasitic infections that infect man, schistosomiasis is one of the most widespread, in about 74 developing countries with more than 80% of the infected people living in sub-Saharan Africa (WHO, 1990). Urinary schistosomiasis, for instance, is reported as more than 44 African countries (WHO, 1995). In Nigeria this debilitating disease is endemic and widespread as can be seen in table 1. The effect of Nigerian environment on the distribution and extensity of the disease as well as the possible impact of climate change on the epidemiology are discussed in this paper.

Schistosomiasis and Nigerian Environment

The high incidence of schistosomiasis in tropical African including Nigeria is the result of the combined effects of ecological and parasitological factors, human behavioural and cultural practices, as well as the socio-economic conditions of the people (Ukoli, 1990). Exposure to infected water is necessary for man to contact schistosomiasis because it is transmitted by freshwater planorbids snail species. And since infection cannot occur if the right type of snail species is not present in the water; neither can the snails survive and attain the right populations density if the right ecological factors do not exist, the consensus opinion is that "the ecological factors, the bionomics of the snail vectors, and the variations in the internal environment provided for the parasite by the vertebrate and snail hosts have a greater impact on the dynamics of transmission" than the socio-cultural component.

Contact with infected fresh water bodies (rivers, streams, dams, lakes, ponds, drainage, channels, seepages, springs, swamps, paddy fields etc) which abound in the country is very necessary for man to contact schistosomiasis because the snail vectors breed in these habitats. One of the strongest and most inevitable associations in nature is that which exists between man and water (Edungbola, 1980). Wright (1971) noted that the parallel evolution of the parasites and their snail and human hosts, showed how man continued to be closely associated for most of his occupational, recreational and domestic needs, with the freshwater habitats of the planorbids under the very conditions best suited for the transmission of the parasite. This is compounded by the fact that a United Nation's report indicated that the great majority of the world population, especially in the developing world (including Nigeria) lack reliable sources of drinking water (Balance and Gunn, 1984). The promiscuous contamination of these water bodies with human excrement (due to inadequate waste disposal facilities and rural habitats), especially by children pose serious public health problems with regards to the transmission of water-related water-

Table 1: Some of the results of prevalence survey of human *Schistosomiasis* in Nigeria

SOURCE/PREVALENCE	PREVALENCE RATE (%)		AREA OF STUDY
	S. haematobium	*S. mansoni*	
Abubakar *et al.*, (1991) Abtr. Nigeria Soc. Parastol. 15:9	74.6	-	Dunday village, Sokoto State
Adamu and Musa (1998). Nig. J. Parastol. 19:73-75	50.09	-	Bakolori irrigation area, Zamfara State
Adamu *et al.*, (2001). Nig. J. Parasitol. 19: 73-75	41.0	5.0	Wurno District, Sokoto State
Adeoye and Ipeayeda (1993). Abstr. Nig. Soc. Parasitol. 17:17	67.9	-	Owena Army Barracks, Akure
Agi. (1995). West Afr. J. Med. 14(1): 6-10	>60.0	-	River State
Akogun and Obidah (1996). Nig. J. Parasitol. 17:11-15	65.82	-	Gyawana Plantation School Numan, Adamawa State
Akogun and Amos (1997). Abst. Nig. Soc. Parasitol.	46.0	60.04	Savannah Sugar Plantation, Numan
Akugongwe *et al.*, (1995). J. Helmintol. 69:1-4	47.8	-	Jos, Plateau State
Amali (1991). Abst. Nig. Soc. Parasitol. 15:8	15.3	-	23 LGAS in Benue State
Anosike *et al.*, (2000) Int. J. Environ. Hlth. Hum. Develop. 1:6-13	29.4	-	Ozitem Bende LGA, Abia State
Anosike *et al.*, (2002). Int. J. Environ. Hlth. Hum. Develop.	23.5	-	Ebonyi River Valley Communities
Anya and Okafor (1987) Bull. De. ILFAN. 46: 321-332.	32.41	-	Anambra State (old)
Daniel *et al.*, (2001) Nig. J. Parasitol. 22(1and2): 65-74.	60.2	1.0	Zuru Emirate, Kebbi State
Dunah and Bristone (2000). Nig. J. Parasitol. 21:15-20.	27.2	-	Mayo-Belwa LGA Adamawa State
Etim *et al.*, (1998). Nig. J. Parasitol. 9:77-83	35.95	-	Biase LGA, Cross River State
Idris *et al.*, (2001). Nig. J. Parasitol. 22(1and2): 75-8	12.05	3.3	Few LGAS in Karsina State
Mafana and Adesanya (1994). Nig. J. Parasitol. 15: 51-57	76.0	-	Flemo-Orile, Ogun State
Matur (2000). Abstr. Nig. Soc. Parasitol. 24: 32	72.32	-	Gwagwalada, Abuja
Ogbonna and Okonkwo (2000). J. Med. Lab. Sc. 9: 21-25	39.02	-	Lamingo, Jos North LGA
Obi *et al.*, (1994). Abstr. Nig. Soc. Parasitol. 18:12	20.0	-	Edo State
Onwuliri and Uzokwe (1988). Nig. J. Biotech. 15: 156-159.	-	27.2	Jos Plateau
Oyediran (1976). M.D. thesis, University of Ibadan	41.6	-	Epe Community
Pugh and Cailles (1976). Abstr. Nig. SDoc. Parasitol. 24:32	70.0	-	Malumfashi District, Northern Nigeria
Sulyman *et al.*, (2000). Abstr. Nig. Soc. Parasitol. 24: 32	72.32	-	Ogun, Ondo, Borno and Niger States
Thomson (1967). Trans. Roy. Soc. Trop. Med. Hyg. 61: 277-289.	20.0	32.0	Bacita sugar estate Northern Nigeria
Ugbomoike (2000). Nig. J. Parasitol. 21: 3-14.	22.9	-	14 LGAS of Edo State
Ogonobo and Okafor (1987). Nig. J. Biotech. 4: 176-178.	20.0	-	South Chad irrigation Area
Uko *et al.*, (1993). Nig. J. Parasitol. 14: 65-73	23.0	-	Kainji lake area

borne parasitic diseases such as schistosomiasis (Weller, 1975). This is because the villagers also use these same contaminated water bodies for domestic, recreational and religious activities. These account for the higher prevalence of schistosomiasis in the drier savanna and semi-arid regions than in the tropical rainforest and coastal areas of the continent. Children have high habit of visiting and using these contaminated waters. The high temperatures in tropical Africa, particularly in the afternoons, make the cool and refreshing nature of the water irresistible to the children after school or a hot day's work in the school (Ukoli, 1990). This therefore enhances the disease transmission among these groups.

To meet the demands of the ever rising human population of Nigeria, most of the major river systems, especially in the savanna and semi-arid regions, have, in recent times been modified into man-made lakes and irrigation projects. The construction of man-made lakes resulting from river impoundments and the extension of irrigation projects in Nigeria can be justified from point of view of economic and social necessities such as hydroelectric power supply, flood control, improved transportation, improved agriculture, development of inland fisheries as well as recreational facilities. In some countries, well-designed and constructed irrigation system with efficient drainage, correctly prepared land, and sound water – management, adequate maintenance and good agricultural practices have prevented any major ecological problem (Jordan and Webbe, 1986). Unfortunately, however, the pressure and political zeal under which the relevant authorities of some tropical African countries embark on these development projects sometimes prevent them from building in proper precautionary measures against environmental and health problems. One of the results of this is increase threat to public health. Our drive for development through the many River Basin authorities and the irrigation and hydro-electric dams spawned in their wake throughout Nigeria will, unless adequate scientific knowledge is utilized now, lead to an epidemic of this disease (Schistosomiasis) in many parts of Nigeria (Anya, 1987). By this, these schemes have either aggravated the prevalence of parasitic diseases or directly introduced them into new areas by providing new and permanent habitat for the disease pathogens and their vector species (Nwoke et al, 1989).

The great modifications of the environment through man-made lakes and irrigation projects in Nigeria have favoured the multiplication and spread of snail vectors of schistosomiasis. This has as a result produced dramatic increase in the disease prevalence. For instance, the completion of the Kainji Dam in 1970 in Nigeria created a man-made lake of 1600 Km^2 with the lakeside prevalence of *S. haematobium* of up to 62% in some villages (Hunter et al, 1973). In their study, Doza and Biles (1972; 1973) reported that the prevalence and intensity of schistosomiasis were much higher around the lake area than in the nearby New Bussa. On the adjacent irrigated project on the eastern side of Kainji Lake, Adekolu-John (1983) and Adekolu-John and Abolarin (1986) observed that the prevalence rates of both *S. haematobium* and *S. mansoni* infections were up to 30%. Further to the northern part of the country, around the Funtua Agricultural Development Project at Malumfashi District, where about 16 earth dams were built, Pugh and Gilles (1978) reported an overall prevalence rate of 13.5% for *S. haematobium*; and also observed an infection rate as high as 41.2% among the boys aged 5 -15 years in 1976. In another study, Tayo and Jewburry (1978) observed that within six months of the construction of Ruwan Sanyi Dam also in Funtua, dense population of *Bulinus (Bulinus) globosus* colonized the entire lake margin. There was also increase in the prevalence of urinary schistosomiasis up to 37% around the Tomas and Rimin Gado dams after completion (Betterton et al, 1988). The situation was also similar to what happened at the Lake Chad irrigation project in Borno state where Noamesi and Morcos (1974) recorded an increase of 60% prevalence of urinary schistosomiasis in some villages within the irrigation project.

In irrigated areas, infected as well as uninfected persons are brought together to work and live. Water-contact activities whether for farming, domestic or recreational needs usually make use of irrigation canal waters. Human waste is often excreted or washed into the same water where snail vectors are abundant. The men work in the water, children play and fish in it, and women fetch water and wash laundry in it. This deadly combination is all that is needed for the rapid spread of the disease. Wright (1968) observed that the economic exploitation and opportunities offered by the irrigation schemes and impoundments have brought about growth and great mobility of human populations to those areas. These have increased contact between infected humans, snail vectors and apparently healthy people, thus increasing the disease transmission and dissemination.

In addition to dams and irrigation schemes, other careless engineering practices/constructions in the country that have been known to create favourable breeding sites for the snail vectors as well as perpetuation of schistosomiasis transmission include ditches, burrow-pits, quarries, and pools. These environmental modifications notwithstanding, schistosomiasis in Nigeria and other tropical African countries is widely transmitted in natural water bodies which abound in the endemic communities (Ukoli and Asumu 1979). Also, socio-cultural environment such as local beliefs or conception as well as cultural practices in endemic communities in the country tend to encourage the spread of the disease. For instance, the belief by some villagers in endemic areas that the schistosomiasis symptom, haematuria (i.e. blood in the urine) among the infected boys is a male version of menstruation signifying the onset of puberty is misleading and therefore hinders any modern control measure. This may also be the perception of ancient Egyptian society for using the covering of the tip of penis with a metal cap, be it of gold, silver, copper or lead (depending on the economic status of the wearer), as a preventive measure against the disease (Ukoli, 1992). In addition, religious exposure may play a role in the spread of schistosomiasis in the country. For instance, among the Muslim society, religious practices, such as ablution and wadu (ritual washing), are required of male Muslims several times a day. Wadu is performed only by males and entails washing three times all exposed parts of the body or of the total body surface. Kuntz (1952) working in Yemen, southwest Arabia reported that ablution pools of some Mosques have, at times, become contaminated with schistosomiasis snail vectors and may serve as sites for the disease transmission: such practices may contributes to higher male prevalence rate of the disease) in such Muslin communities. The high gender prevalence ratio noticed in the studies of Pugh and Gilles (1978) in Ruwan sanyi village in the northern part of Nigeria, "were attributed to cultural traits of the inhabitants (Hausa, Fulanis, and Maguzawas) who are rather strict Muslims who markedly restrict the activity of their women".

Climate Change and Schistosomiasis

Climatic factors vary naturally around the world without obvious notice, and at the same time comfortably maintaining the various natural and ecological systems. In the last 2-3 decades, however this variation has gone beyond the natural levels that climatologists are now in general agreement that the world has begun to experience the process of global " climate change". Human activities, principally the burning of fossil fuels, have increased the atmospheric concentration of important green house gases, which may result in warming of the earth's surface (IPPC, 1996). In his work on "planetary overload", McMichael (1993) stated that "human – induced climate change is now compromising the sustainability of human development on the planet because it threatens the ecological support systems on which human life depends – affecting human health. The effects of climate change and ozone depletion on man is both direct and indirect and are summarized in Fig. 1. One of the indirect effects is the influence on vector-borne diseases (Patz et al, 1996).

Vector's geographical distribution and vectorial capacity are the two most important determinants of disease transmission (Longstreth, 1989). And these determinants are especially influenced by temperature, precipitation, humidity and surface water availability as well as biotic factors. The current climate change scenario is expected to cause widespread shift in the pattern of a number of infectious and parasitic diseases and alter the life cycle dynamics of intermediate hosts and vectors. This change will also dramatically influence the transmission potential of the intermediate hosts and vectors. The major vector-borne diseases and the likelihood of change in their distribution as a result of climate change has been assessed and presented by several workers (PAHO, 1994, WHO, 1995; Michael and Bundy 1996). By this assessment and ranking the geographical distribution of schistosomiasis and other vector borne diseases (onchocerciasis, dengue, yellow fever) are very likely to be affected by climate change.

The eggs/ova of *Schistosoma* parasites passed out via urine (mainly in *S. haematobium*) or excretment (in *S. mansoni*) require fresh water environment to hatch into miracidium. The penetration of miracidium into snail intermediate host, the development in the snail vector, and the emergence of infective stage, the cercariae and their survival and penetration into human host are all influenced by both intrinsic and extrinsic (environmental) factors. Again, the availability, development and survival of snail intermediate hosts in the freshwater environment are determined by the physicochemical properties of the water. Empirical evidences abound to highlight the effect of aquatic environment on the miracidium, cercaria and the freshwater snail intermediate hosts.

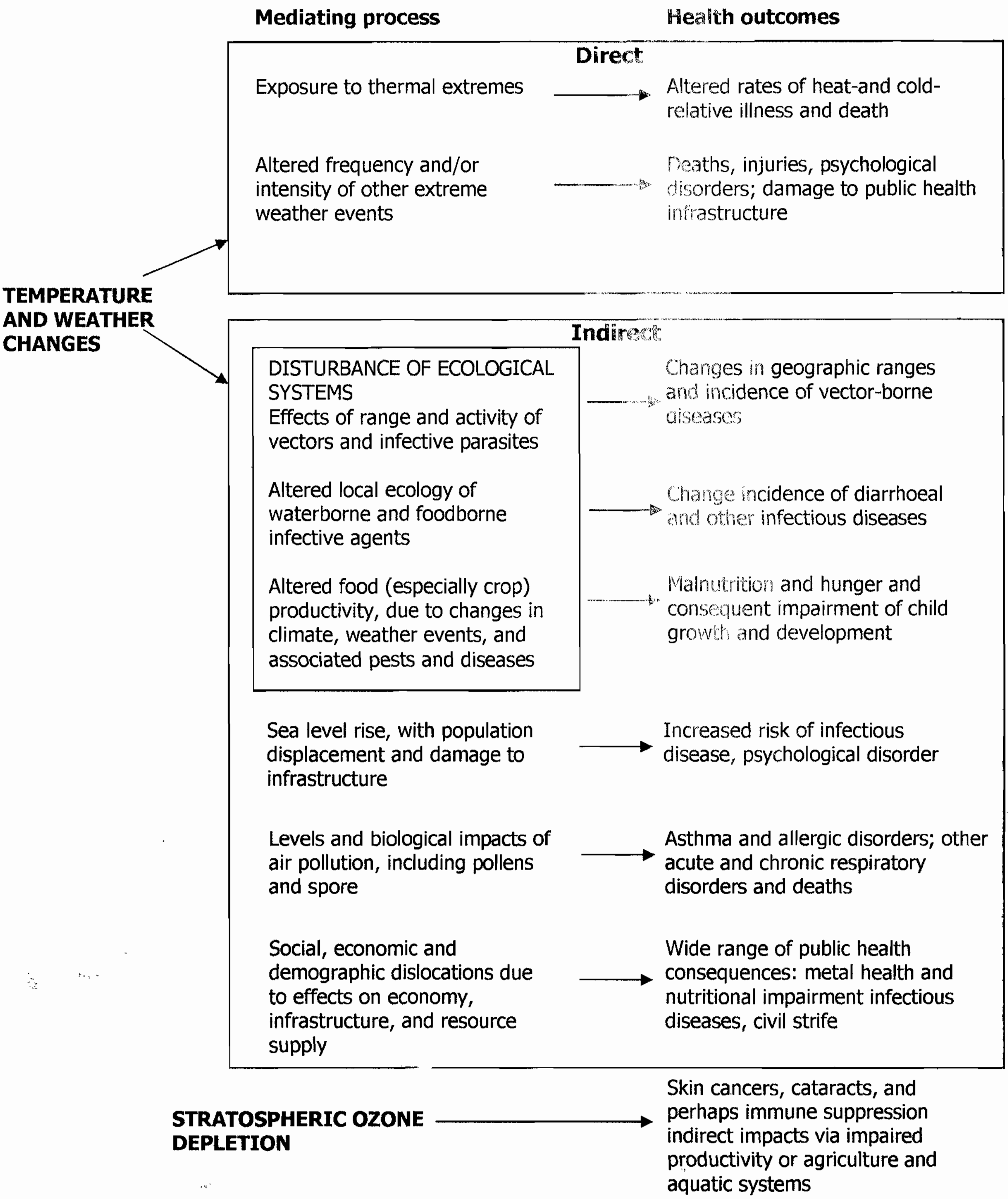

FIG 1: Possible major types of impact of climate change and stratospheric ozone depletion on human health (Patz and Balbus, 1996)

The miracidium and cercaira, the aquatic stages of *Schistosoma* species are non-feeding and short-lived. They rely on the stored glycogen in their bodies for survival; the duration of their survival or viability therefore depends on the quality of the stored glycogen. However, Jordan and Webber (1982) reported that extrinsic factors, especially water temperature which stimulate the use of the stored glycogen curtail larval viability. The aquatic stages of *Schistosoma* survive longer in moderate temperatures than at very high or low temperatures. In other words, extreme water temperatures, for example, reduce the duration of viability of these larval stages- which in effect affect the disease transmission. The work of Prah and James (1977) pointed out that the optimum temperature for the survival of aquatic stages of *Schistosoma* is about 15°C. At low temperatures the activity of both miracidium and cercariae are consequently reduced; but with increase in temperature both the snail vectors, miracidium and cercaria become more active – and the infections of both snails (by miracidium) and man (by cercaria) are favoured. In fact, infection of schistosoma does not occur at all at temperatures below 9°C while the maximum infection of man by cercaria is achieved at 24°C – 27°C (WHO, 1996). The work of Purnell (1966) described a linear function of relationship between the infective rate of snail achieved by miracidium and temperature up to thermal death point of snail of 39°C. And for the cercaria infection of man, he observed a curvilinear relationship up to a peak of 24°C, which then decreases symmetrically. Freshwater snail intermediate host of schistosomiasis are affected by climate variables. Rainfall, for instance determines the duration of desiccation, and these snail intermediate hosts are affected by fluctuations in the water levels, physicochemical properties and by rapid increase in water velocity – all of which affected by the degree of rainfall (Sturrock, 1973). However, Mitchell and Ingram (1992) were of the view that "the relationship between changing temperatures, precipitation and relative humidity are complicated, and that the process affecting atmospheric humidity suggests only a small change in relative humidity as the atmosphere gets warmer due to green house effect".

Schistosomasis is a major water-based parasitic disease and any climate change or environmental modification/degradation that affects the physical and or chemical properties of the water bodies and human behaviours as well as the contact of man with snail-infested water bodies will definitely affect the disease prevalence and distribution. Results by white et al (1942), Grosse (1993) and Hentor et al (1993), for instance, have shown that the global prevalence of human schistosomasis has risen since the middle of the 20th century. This has been largely because of the expansion of irrigation systems in hot tropical climates where conditions have been made favourable for both human population and for the fact that temperature influences snail vector reproduction and growth, schistosome mortality, infectivity and development in the snail host, and human-water contact (Martens et al, 1995). Any shift in climatic variable (may be due to climate change), especially temperature, would affect the regional and global distribution of schistosomiasis . Gillett (1974) and Shchiff et al (1975), for example, reported that during winter, the snail intermediate hosts tend to loose their *Schistosoma* infections; but if temperatures increase, snails transmit the disease for a longer period during the year.

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