Environmental Conditions Associated with Vector of Dengue and Corrective actions for its Prevention in Nepal

October, 2009

World Health Organization

Nepal Health Research Council

Environmental Conditions Associated with Vector of Dengue and Corrective actions for its Prevention in Nepal

October, 2009

Advisor

Dr. Mahesh Kumar Maskey

Study Team Members

Mr. Meghnath Dhimal, *Co-ordinator*
Mr. Ajoy Kumar Thakur, *Entomologist*
Eng. Sarita Maskey Shrestha, *Urban Planner*
Dr. Manas Kumar Banerjee, *Dengue Specialist*
Ms. Lila Bhattarai, *Research Assistant*

World Health Organization

Nepal Health Research Council

Published by

Nepal Health Research Council
Ramshah Path, Kathmandu, Nepal

First Edition : October 2009

Printed Copies : 250 pcs.

Cover Photo– An adult *Aedes segypti*

Print & Design in Nepal by
Suraj Printing Press
Tel.: 4252333
email: suraj@info.com.np

Acknowledgement

I would like to thank all those who have worked in this research project to make it a success. It is with deep appreciation that NHRC acknowledges the contribution of study team and support of Dr. Sarita Upadhyaya, Member-Secretary of NHRC.

I express my deep gratitude to Mr. Meghnath Dhimal, Environmentalist and Coordinator of the project, Mrs. Sarita Maskey Shrestha, Urban Planner, Mr. Ajoy Kumar Thakur, Entomologist for their valuable contribution to accomplish the research timely. NHRC also acknowledges the valuable contribution of Dr. Manas Kumar Banerjee, Dr. Basu Dev Pandey and Dr. Gajananda Prakash Bhandari for their insightful review of the report and their feedback and suggestions to update the report.

I am thankful to the World Health Organization Country Office Nepal for financial and technical support to accomplish this research. My special thanks go to Mr. Han Heijnen, Environmental Health Advisor of WHO for his guidance and comments on interim report. Special thanks go to Lila Bhattarai, Research Assistant, who worked meticulously for producing this valuable document.

At last but not the least, I would like to thank all who were present in the stakeholder meeting organized for sharing the findings for their valuable comments especially Dr. Dirgha Singh Bam, Health Secretary and Dr. Govinda Prasad Ojha, Director General of Department of Health Services, Ministry of Health and Population.

Dr. Mahesh Kumar Maskey
Executive Chairman

Table of Contents

List of Tables

List of Figures

1 Introduction

Dengue is a climate sensitive vector borne diseases, which in recent years has become a public health concern. Dengue is transmitting in tropical and sub-tropical regions around the world, predominantly in urban and suburban areas (WHO Fact Sheet 2006). Domestic Dengue virus(DV) infection occurs in more than 100 countries and over 2.5 billion people live in the areas with a risk of dengue virus infection(WHO,1999,2002). Up to 100 million cases of Dengue fever(DF) and 500,000 cases of Dengue Hemorrhagic Fever (DHF) and several thousands deaths are estimated to occur annually worldwide (WHO). During the past decades, dengue virus emerged in South Asia and DF/DHF epidemics occurred in Bhutan, India, Maldives, Bangladesh and Pakistan (WHO, 2007). The global prevalence of dengue has grown dramatically in the recent decades.

The principal vector of dengue virus is the mosquito *Aedes aegypti.* Dengue virus is maintained in a cycle between humans and *Aedes aegypti,* domestic day biting mosquitoes. There is limited information available on dengue viral infection in Nepal. In Nepal, the first case of dengue was reported in 2004 from Chitwan district (Pandey et al 2004). Sporadic cases were reported since 1990's in a Japanese travellar who visited Nepal and developed DF after returning to Japan. Outbreak of Dengue occurred in Nepal in 2006. From August through November 2006, the number of febrile patients increased in four major hospitals in the Terai region of Nepal: Nepalgunj Medical College, Bheri Zonal Hospital in Nepalgunj, Tribhuvan Hospital in Dang and Narayani subregional hospital in Birgunj. Patients with severe symptoms were referred to Sukraraj Tropical and Infectious Diseases Hospital, Kathmandu for diagnosis and treatment. The clinical features in most patients were consistent with the signs of DF (Pandey et al, 2008).

Aedes aegypti was identified in 5 major urban areas of terai region bordering with India, i.e. Biratnagar (Morang), Birganj (Parsa), Bharatpur (Chitwan), Tulsipur (Dang) and Nepalganj (Banke) during the entomological surveillance in Japnese Encephalities endemic district after the Dengue outbreak in 2006 in Nepal(WHO, 2006).The larvae of *Aedes aegypti* was also recorded in Kathmandu during June 2009 (Gautam et.al 2009). It is important to assess the changes in the environmental conditions, increased vector densities associated with the *A. aegypti* and develop some corrective manual which help to control the vectors in communities and apply preventive approaches for such diseases among the public.

1.1 Background

Dengue and Dengue Hemorrhagic Fever (DHF) is an acute viral disease. DF is a self – limiting disease and represents the majority of cases of dengue infection. In some peculiar epidemiological situation, depending on the circulating virus and host immune status it manifests as a severe and fatal hemorrhagic disease known as DHF. These two severe forms of dengue, namely DHF and DSS, if not properly managed, may lead to death.

DF/DHF is now endemic in more than 100 countries and threatens the health of about 40% of the world's population (2.5 billion), particularly in tropical and subtropical regions and predominantly in urban and periurban areas. Over 1.2 million cases were reported to WHO in 1998, the greatest number ever for a single year. There are an estimated 50 million infections annually, including 400,000 cases of DHF(WHO,1999).

A. aegypti has been incriminated as the principal vector which is primarily an urban mosquito but sometimes it is also found in the periphery of cities breeding in rain water accumulated in tree holes. The virus has also been isolated from *Ae. albopictus*. This species is mainly urban and semi-urban, breeding in domestic and peridomestic water storage containers.

The disease occurs in epidemic form during late monsoon and post-monsoon season, as an outcome of increase in breeding places and vector population. However, outbreaks of considerable magnitude have also occurred during the summer and pre-monsoon season as a result of water scarcity and consequent storage of water for domestic purposes.

Because dengue infections have the potential of rapid spread leading to acute public health problems, special attention is required to be paid for its surveillance, prevention and control.

1.2 Overview of Dengue situation

Dengue in South East Asia Region

Of the total world population of 6.2 billion, countries of the South-East Asia Region (SEAR) account for 1.5 billion (24%). On that scale, of the 2.5 billion people (living in the tropics and sub-tropics) at risk of DF/DHF, 52%, i.e. 1.3 billion populations, live in SEAR.

In 2003 only 8 countries in South East Asia Region reported dengue cases. As of 2006, ten out of the eleven countries in the Region (Bangladesh, Bhutan, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste) reported dengue cases. Bhutan reported the first dengue outbreak in 2004. An outbreak, with a high case fatality rate (3.55%) was first reported in Timor -Leste in 2005. Nepal reported dengue cases for the first time in 2004 from Chitwan district. The Democratic Peoples' Republic of Korea is the only country in this Region of WHO that has no report of indigenous transmission of DF/DHF.

For the South East Asia Region as a whole, there is about 18% increase in number of reported cases and about 15% increase in the number of reported dengue deaths in 2007 as compared to same period last year. There was substantial increase in the reported cases of dengue in Thailand, Indonesia and Myanmar.

Situation in Nepal

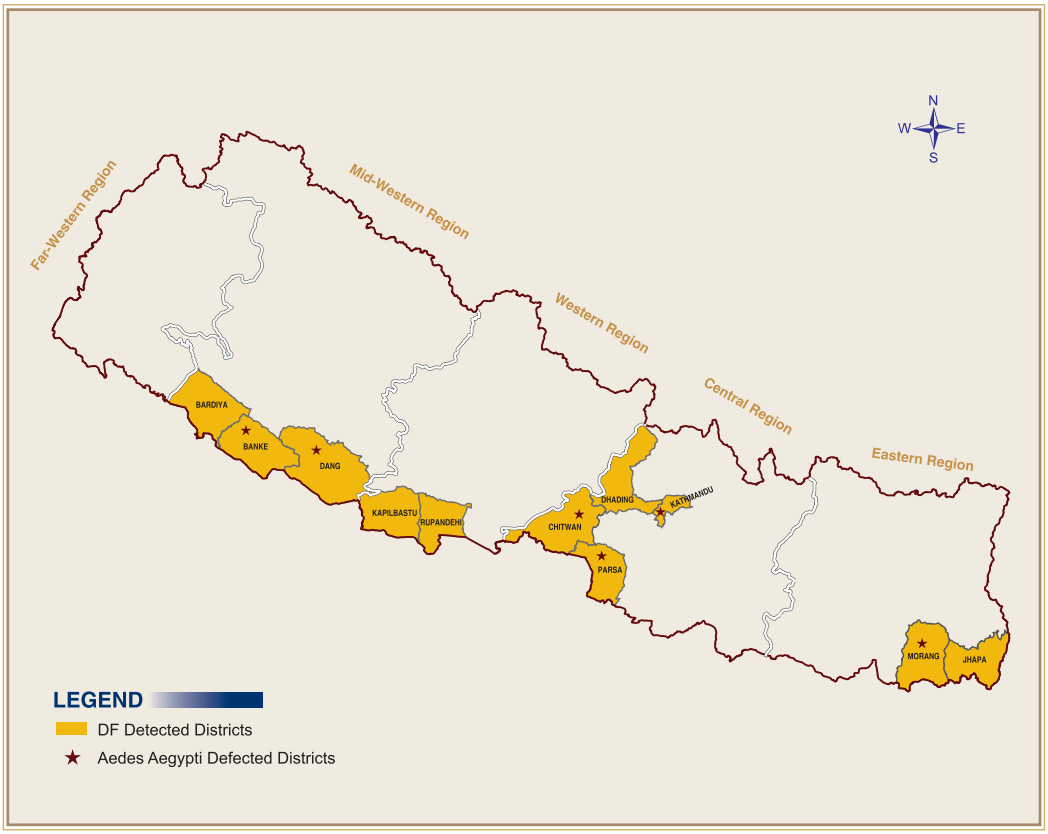
In 2006, there were reports of suspected DF outbreaks in Banke district. The clinical observation, pathological and laboratory investigation results proved introduction of DF in Banke, Bardiya, Dang, Kapilbastu, Parsa, Rupandehi, and Jhapa districts. A total of 70 serum samples from suspected DF cases were collected from 19 districts. So far, 22 cases of DF had laboratory confirmed and many patients had travel history to India. It was also reported that many patients having similar symptoms visited India for treatment and confirmed as DF. Seventy-five per cent DF cases were reported in October and few cases were reported in September and November. Only 11 per cent patients had travel history to India in past two week period prior to clinical manifestation of DF. Ninety-four per cent patients were adults and male to female ratio was 4:1.

Table 1 Distribution of Estimated and Detected DF Cases, Nepal, 2006

District	Affected area	Detected DF cases	Estimated DF cases	Remarks
Banke	Urban/suburban	10	50	India-2
Bardiya	Urban/suburban	3	15	Rajasthan-1
Dang	Urban/suburban	6	30	No
Jhapa	Suburban	1	5	No
Parsa	Urban	4	20	No
Rupandehi	Urban	2	10	No
Kapilvastu	Urban	1	5	Unknown
Dhading	Urban	1	1	Unknown
Kathmandu	Urban	4	4	India-1
Total districts-9	**Urban/suburban**	**Total detected-32**	**Total estimated-140**	**Imported cases-4**

Source: WHO 2006

Under reporting is expected in the absence of diagnostic facilities at the field level and it may be reported either as viral fever or Pyrexia of Unknown Origin (PUO).



Source: WHO 2006 Updated

Figure 1 Map of Nepal showing the Dengue detected districts

2 Epidemiological Characteristics

Agent factors

Causative agent: It is caused by four closely related virus serotypes of the genus Flavivirus, family Flaviviridae. Each serotype is sufficiently different that there is no cross-protection and epidemics caused by multiple serotypes (hyperendemicity) can occur. DEN-1, DEN-3 and DEN-4 have been found in Nepal which indicates the possibility of severe form of disease, i.e. (DHF) during outbreaks.(WHO, 2006)

Vector: Dengue is transmitted to humans by the *A. aegypti* (rarely *Aedes albopictus*) mosquito, which feeds during the day. In the South-East Asia Region, *Aedes aegypti* is the principal epidemic vector of DEV. *A. albopictus* has been recognized as a secondary vector, which also is important in the maintenance of the viruses. *A. aegypti* has been recorded and identified deploying entomological survey techniques in five major urban areas of terai region Biratnagar and Bhadrapur (Eastern region), Birgunj (Central region), Tulsipur and Banke(Midwestern region), which is suggestive of possibility of local transmission of the disease.

Reservoir of infection: DEV infect humans and several species of lower primates. Humans are the main urban reservoir of the viruses. Studies in Malaysia and Africa have shown that monkeys are infected and are the likely reservoir hosts, although the epidemiological significance of this observation remains to be established.

Host factors

Man is the definitive host and mosquitoes are the intermediate host.

Age and sex: All ages and both sexes are susceptible to DF. However, it is estimated that 90% of the DHF cases occur in children under the age of 15 years.

Immunity: There are four distinct, but closely related, viruses that cause dengue. Recovery from infection by one provides lifelong immunity against that virus but confers only partial and transient protection against subsequent infection by the other three viruses. There is good evidence that sequential infection increases the risk of developing DHF.

Mobility (migration): The movement of people from one place to another has led to the extension of dengue into areas previously non-endemic. Some cases in 2006 outbreak in Nepal have already been identified to be transmitted to Nepal from India. It is believed that the global spread of dengue can be attributed to increase in global travel and trade.

Environment factors

Geographical distribution: It is mostly prevalent in the tropics and Africa. The geographical spread is similar to malaria, unlike malaria, dengue is often found in urban areas of tropical nations, including Puerto Rico, Singapore, Malaysia, Taiwan, Thailand, Indonesia, Philippines, India, Brazil and Venezuela. In SEAR, *Ae. aegypti* is widespread in urban areas of tropical and subtropical regions of South-East Asia. The rural spread of *Ae. aegypti* is a relatively recent occurrence associated with the development of rural water supply schemes and improved transport systems. In Nepal, laboratory results proved introduction of DF primarily in Terai districts of Nepal; Banke, Bardiya, Dang, Kapilbastu, Parsa, Rupandehi, and Jhapa. Moreover, *A. aegypti* has been identified in five major urban areas of Terai region & Kathmandu which suggests that DF transmission may occur locally in Terai districts & Kathmandu valley if imported cases are introduced.

Climate: Climate is an important factor in the epidemiology of dengue as it influences the distribution and densities of vector mosquitoes. Evidences show that season, rainfall, temperature and affects dengue transmission.

Season: Dengue is seen to be affecting throughout the year depending upon various climatic and geographical factors. The peak month for Dengue cases in 2007 in Indonesia was February, June in Thailand and July in Myanmar.

First DF case was reported in Kathamndu in September 11, 2006. The patient had travel history to India. Seventy-five per cent DF cases were reported in October and few cases were reported in September and November. Clusters of DF cases were reported in mid October in Banke and Dang districts which may be indicative of probability of local transmission among patients having no travel history.

Altitude: Altitude is an important factor in limiting the distribution of *Ae. aegyptis,* In countries of South-East Asia, 1000 to 1500 meters appears to be the limit for *Ae. aegypti* distribution. In other regions of the world, it is found at even higher altitudes, i.e. up to 2200 meters in Columbia.

Temperature: Temperature plays an important role in the transmission of dengue virus by mosquitoes. Mosquitoes kept at 26^{o}C fails to transmit DEN2 virus. Hence, low incidence of DHF in certain seasons could be explained by this observation. Temperature affects the growth and multiplication of the vector. At low temperatures, it may take several weeks for adults to emerge.

Rainfall: Studies suggest that rainfall patterns seem to be a reasonably effective predictor of time of peak dengue transmission which occurs about six or eight weeks after the peak in rainfall. A five year study in Indonesia showed DHF cases started to rise after about 4 weeks of the peak rainfall and within the next 4 weeks the peak dengue transmission was recorded.

Moreover, where the annual rainfall is greater than 200 cm, *Ae. aegypti* populations are more stable and are established in urban, semi-urban and rural areas.

Climate change: The World Health Organization (WHO) states that 2007 is fourth consecutive year of unusually high rates of Dengue in the SEAR and experts are worried that global warming may be partially to blame.

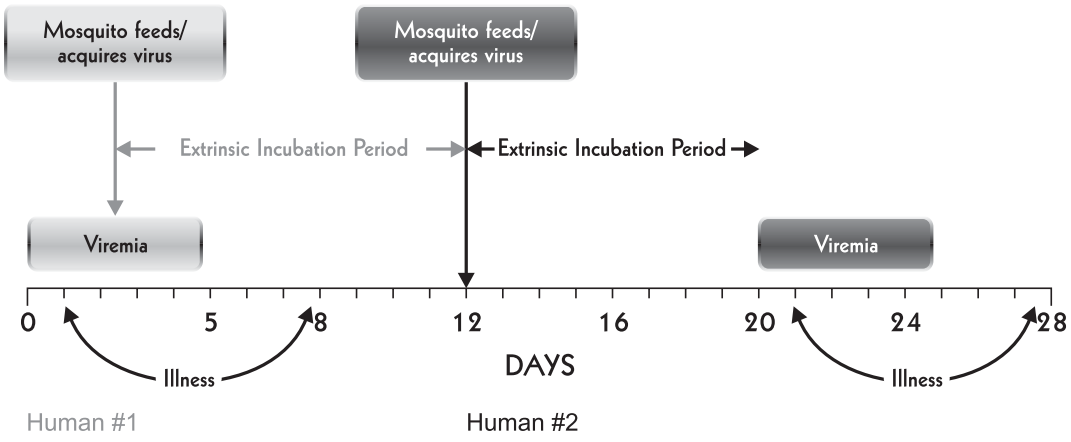
3 Mode of Transmission & Incubation Period

DEV are transmitted to humans through the bites of infective female *Aedes* mosquitoes. Mosquitoes generally acquire the virus while feeding on the blood of an infected person. After virus incubation for eight to ten days, an infected mosquito is capable, during probing and blood feeding, of transmitting the virus for the rest of its life. Infected female mosquitoes may also transmit the virus to their offspring by transovarial (via the eggs) transmission, but the role of this in sustaining transmission of the virus to humans has not yet been defined.

Infected humans are the main carriers and multipliers of the virus, serving as a source of the virus for uninfected mosquitoes. The virus circulates in the blood of infected humans for two to seven days, which correlates with a fever; *Aedes* mosquitoes may acquire the virus when they feed on an individual during this period of fever. Some studies have shown that monkeys in some parts of the world play a similar role in transmission.

3.1 Lifecycle of Aedes mosquito

The reservoir of infection is both man and mosquito. The transmission cycle is "Man-mosquito-man". *A. aegypti* is the main vector. The Aedes mosquito becomes infective by feeding on a patient from the day before onset to the 5th day (viraemia stage) of illness. After an extrinsic incubation period of 8 to 10 days, the mosquito becomes infective, and is able to transmit the infection. Once the mosquito becomes infective, it remains so for life. Transovarian transmission of dengue virus has been demonstrated in the laboratory.



Source: WHO 2006

Figure 2 Outline of DEV life cycle

The illness is characterized by an incubation period of 5-6 days for both DF and DHF.

4 Clinical Manifestations & Treatement

Clinical Manifestations

The sign and symptoms for DF and DHF can be illustrated as follows:

Recognition of Dengue Fever

- Sudden onset of high fever
- Severe headache (mostly in the forehead)
- Pain behind the eyes which worsens with eye movement
- Body aches and joint pains, hence the name bone breaking fever.
- Nausea or vomiting

Recognition of Dengue Haemorrhagic Fever and Shock

Symptoms similar to dengue fever plus, any one of the following:

- Severe and continuous pain in abdomen (Sign of severity of DHF)
- Bleeding from the nose, mouth and gums or skin bruising.
- Frequent vomiting with or without blood;
- Black stools, like coal tar;
- Excessive thirst (dry mouth)
- Pale, cold skin
- Restlessness or sleepiness

Treatment

There is no specific medicine for the treatment of the disease. However proper and early supportive treatment can relieve the symptoms and prevent complications and death. Aspirin and Brufen should be avoided in DF, as it is known to increase the bleeding tendency and also it increases the stomach pain. Paracetamol can be given on medical advice. If one or more signs of DHF are seen, the patient should be immediately taken to the hospital. While transferring the patient to the hospital, giving enough fluids to drink is recommended.

5 Preparedness for DF/DHF/DSS prevention in Nepal

Following are the preparedness for DF/DHF/DSS prevention in Nepal:

- NPHL staff oriented on Dengue Serology
- Laboratory technicians and assistants from 23 districts trained in DF serological diagnosis with technical assistance from WHO/SEARO.
- Terai district hospital staff oriented in DF/DHF/DSS diagnosis and treatment
- Entomological surveys larval collection orientation in five districts
- Entomological training conducted for Vector Control Assistants on Dengue vector identification
- Guidelines for management of DF/DHF/DSS has been prepared and disseminated
- Rapid Diagnostic Kits have been dispatched to the districts.
- Clinicians trained at National Children hospital, Thailand.
- A National focal person to establish for dengue net establishment nominated from Ministry of Health and Population.
- Microcentrifuge instrument supplied at six centers including STIDH/KCH to check HCT.

6 Environmental Conditions in urban areas and corrective measures

6.1 Population growth and urbanization

According to the National Urban Policy (NUP) urban means a physically well developed and systematically expanded settlement where at least five thousand inhabitants, at least ten people per hector of land, at least 50 percent of urban population above ten years of age are involved in non-agricultural activities such as industries, business and services. There are 58 municipalities in Nepal and urban population represents 14% of the total population at present. It is projected that the urban population will be 18% by 2015 with minimum systematic expansion and development of physical infrastructure.

It has been found that 55% urban population lacks waste management facility, 46% lack sanitation facility, 47 % are deprived of piped drinking water supply. Urban poor and squatters are increasing. This situation is due to population increase and unmanaged planning. Inadequate physical infrastructure, inadequate waste management, pollution, encroachment of public land and resources, decreased of agricultural land and haphazard expansion of urban dwellers, slum and squatters will further aggravate the urban environment causing health related problems such as water-born and vector borne disease such as Dengue. It is, therefore, necessary to analyze the Dengue prone urban components and suggest some of the corrective measures to control such health hazardous elements.

6.2 Environmental Conditions and Corrective Measures

Study on Dengue proliferation in urban environment shows that stagnated water bodies, wet and uncovered dark areas, if left unmanaged for a long period, are prone to water-born vector dieses like Dengue. Planned cities presents compact, efficient land-use, better access to infrastructure and services, efficient resource use, less pollution and minimum waste. A well planned city virtually eliminates the artificial water logging areas and poorly accessible but uncovered dark places. Main issues of Dengue vectors in unplanned cities like in Nepal are as follows:

6.2.1 Slum settlements

Due to small openings there are dark common walkways, corridors and corners as well dark rooms in the houses, especially ground floor is damp and dark that favors situation to house DEV. Leakage from old and poorly maintained pipe lines, storage of water in plastic and tin buckets, use of untreated and uncovered wells, inadequate drainage and dilapidated situation

of paved area in common spaces such as chocks and walkways, deposition of solid waste for longer time within the area. This situation favors efficient spread of dengue and scenario is worrisome.

Corrective Measures

- Campaign for increased awareness about the hygienic living
- Provide adequate light and ventilation in the houses
- Improve drinking water supply, wells, sewer, and drainage system
- Improvement of passage, courtyards and other common spaces

6.2.2 Squatters settlements

Houses are usually of temporary nature and built of old corrugated iron sheets, plastic and other available materials. Rooms are dark and damp without adequate light and ventilation. In these settlements water is stored in various types of old and discarded plastic or metallic utensils and disposed in the nearby peri-domestic environment. Similarly, people uses water from nearby stagnant polluted river or hand pumps without sufficient apron and inadequate drainage creating permanent grey water impoundment. Furthermore, wet waste littering here and there, unpaved earthen approaches with puddles (khalto khulti), open defecation all create poor environment and potential breeding sites.

Corrective Measures

- Provision of basic infrastructure and services such as water supply, paved approaches and sanitary facilities.
- Enforcement of resettlement program
- Improvement of housing quality and built environment
- Campaign for increased awareness about the hygienic living
- Regularly dispose a trash that encourages the accumulation of water.

6.2.3 Urban Road

A number of inner urban roads are found unpaved with potholes or roads are paved without side drainage system or with sub-standard drainage system due to which flooded during the rainy season as a result potholes are impound for longer period. These roads often carry waste water, sewer and storm water to the natural water bodies with a number of blockages on its way as it is designed and constructed in piecemeal and without proper design. Busy road with damaged pedestrian facilities and open drainage manholes may also serve as breeding places during rainy days.

Open bus stops and parking lots are seen unpaved and undulated surface with waste water littered from near by hotel and restaurant making stagnated water pools. Parking vehicles

for longer period or open garages for unused vehicles became breeding sites for urban Aedes as tyres are the one of the most potential breeding places for such vectors. The larvae of A. *aegypti* are reported in discarded tyre in Kathmandu.

Corrective Measures

- Adequate slope and side drains should be provide in urban roads to prevent water from stagnation.
- Urban roads needs to be paved and repair and maintained periodically
- Pedestrian facilities should be paved and manholes should be covered and cleaned periodically.
- All types of parking lots should be paved and provided with drainage systems
- Old tyres and unused vehicles should be kept under roofed garages.
- Clear vector breeding sites regularly in locations where construction activities are going on.

6.2.4 Water supply

City levels: City water supply systems are usually stored in intermittent places from the sources before it gets distributed to city dwellers. Such storage or reservoirs could be breeding points for the vectors if not properly constructed and managed. Rock depression, vegetation and debris could create pockets of standing water that may encourage mosquitoes to breed. Mosquito eggs and larva could get intrude into the water supply systems and be collected in the storage tanks at household level.

Neighborhood level: Water supply distribution points at neighborhood are usually left uncovered or poorly closed after excavation causing depression after some time where water may be collected and stagnated. Such places are vulnerable for vector breading. Impounding due to leakage from old pipes, unpaved surface in city water supply control points may prove habitat for vector dieses.

Household level: Intermittent, inadequate and unreliable supply of city water with low pressure compelled users to use of domestic overhead containers usually made of tin and plastic. Such chambers, distribution pipes, valves, water meters may serve as habitat for *Ae. aegypti* larval. Even water taps remaining wet for a long time may prove vulnerable for breeding place.

Corrective Measures

- City water supply should be provided in regular basis with proper pressure
- City water supply storage systems should be inspected periodically and stagnant water should be removed by filling the potholes by sand/soils.

- Water supply distribution points at neighborhood should be covered and periodically maintained.
- Water storage containers at household level should be covered with mosquito-proof lids and periodically inspected and cleaned.

6.2.5 Natural drainage systems

Increase in urban population made the natural drainage systems' discharge capacity inadequate. Such drainage systems are usually fed with storm water drainage systems that carry thrown away solid waste aggravating poor sanitary conditions of streams and rivers. Storm water drainages system often carry sewage across the city posing nuisance of bad odor, get choked creating black water impoundment for longer period and became breeding places.

Corrective Measures

- Law enforcement should be levied to prevent undue encroachment of natural drainage systems by the settlements.
- Encourage construction of septic tanks to reduce sewage intrusion in to streams and rivers.
- The storm water drain should be sufficiently sloped to carry away the wastewater that flowed into it.
- Regular repair, maintenance and cleaning of storm water as well as natural drainage systems should be done
- People should feel responsible for the facilities and keep them clean (awareness campaign)
- Domestic/industrial wastewater should be treated before draining into the natural surface water bodies.

6.2.6 City Sewerage systems and public toilets

Cite core and its adjacent areas are having old and latter extended sewerage network. It is seen in the core and the adjacent areas that old houses being replaced by commercial and multi-storey buildings. The present sewerage system cannot cope with the increase in urban population. These systems become over flown making stagnated water pools in the road sides, which provides favourable habitat for vectors of diseases. On the other hand, septic tanks are commonly used for reducing pollution in the river. However, poorly constructed septic tanks are also seen over flown during rainy seasons making water logging in the settlement. Public toilets in urban areas are poorly maintained and get over flown with urines making small poundage, which will attract diseases carrying vectors. People are less aware of the danger of such nuisance. Therefore, it is necessary to make them aware of such problems to reduce vector borne diseases such as Dengue.

Corrective Measures

- Promote septic tanks which is the most common method used to treat sewage at household level.
- Introduce and implement low cost, community level treatment plants such as Reed Bed Treatment Plant (RBTP).
- Public toilets should be maintained cleaned periodically.
- Periodic maintenance and renovation of old sewerage system.

6.2.7 Urban waste

Collected waste are stored in intermediate transfer stations located within the city areas with or without recycling facilities before it is transported to the landfill sites. Unpaved ground without closed storage facilities in the transfer station provides ideal breeding sites for mosquitoes. People involved in recycle process without any measures can quickly lead to an epidemic.

Before transported to transfer stations refuses are collected from temporary collection points but it is not collected within due time. Urban People changing there food habits from natural to packed, tinned, bottled liked ready made food as a result there is a increasing amount of non degradable waste in the city. Also a large number of temporary/permanent fast food stalls, food parlors and restaurants in the city highly densify the waste of non degradable nature.

Dumping of discarded vehicles and equipment can be seen in the premises of public institutions and private places. A large number of waste collection depots in operation within residential areas are uncovered or partially covered causing threat of vectors that caries DEV.

Corrective Measures

- Refuse should be stored in transfer stations in protected condition.
- Waste should be collected from temporary collection areas on regular basis
- Workers involved in waste transport and disposal (waste management) especially recycling process should be well protected from mosquito bites
- Municipality should keep waste collection depots under certain operation norms.
- Encourage urban inhabitants to separate their refuse for reduction, reuse and recycle at household level. By doing so, their refuse at compost should be protected from getting wet and should be turned upside down regularly.

6.2.8 Water bodies

Natural wetlands are balanced ecosystems that often contain predatory fish, birds, frogs and insects that help control mosquito population. Direct connection of city untreated sewer, waste dumping, unmanaged cremation and development of squatter settlement along the urban water bodies unbalanced the ecosystem and the water gets fouled becoming breading places.

City level man made water bodies exist for fire fighting, ground water recharge, rainwater and drinking water storage, fisheries and recreational ponds, lakes and irrigation, biological waste treatment plants etc. These water bodies, if not exposed to wind or located indoor, not maintained regular and cleaned, not adjusted water levels create an ideal breeding site for mosquitoes.

House level ponds, pools, ditches, shallow wells etc are usually not rechargeable and stagnant type with possibilities of viruses and space for breeding such viruses. Some sources of stagnant water can be drained or removed so mosquitoes cannot breed. Other sources require regular maintenance, good design and construction to make them unsuitable breeding sites for mosquitoes. This can include ensuring a good location, drainage, wind and adjusting water levels

Corrective Measures

- Regular cleaning and maintenance of local ecosystem
- Avoid dumping solid waste along the bank of water bodies
- Only treated sewer should be connected to the existing river and streams
- Depressions and unnecessary ditches can be filled with clean soil to reduce the pounding of water.
- Ornamental ponds should be construct with nonporous concrete or stone at the bottom and with steep slope to a depth of at least 60 cm
- Introduce mosquito-eating fish (gold fish, koi, etc.) and install an aerator or fountain to the ponds
- Clean and chlorinate swimming pools, outdoor saunas and hot tubs. Cover when not in use.
- At least once per week, drain water that collects on pool covers, window boxes.
- Ditches on private property should be routinely maintained (e.g., mowed, sediment and debris removed)

6.2.9 Building design and construction practice

The main vector, *Aedes aegypti* prefers to rest inside uncovered dark corners of houses and cupboards. It is important to design interior of a building without any open dark spaces or corners and open dark cup boards. Similarly, terraces, balconies, sunshades, porticos and decorative elements in the facades should be well designed so that it drains water properly during rainy seasons and do not get blocked and became breeding sites for Aedes mosquitoes. Special attention should be given to the technical service corners and floors in high rise buildings, where a huge numbers of inlet and outlet pipelines are placed.

Surrounding areas of the buildings such as lawns/flower and kitchen or roof-top gardens and also plastic shades (Greenhouse) for seasonal vegetation should be equipped with drainage system to avoid breeding of viruses. Prefer to build solid boundary walls with sloping on the top and without projections as ornamental elements. Fences and fence posts made of hollow wooden or bamboo should be avoided as these places provide habitats for *Aedes* larvas.

Construction materials such as corrugated sheets, water storage tanks or drums, formwork made from iron sheets should be stored in closed shades. Excavation trench for foundation and pounded curing of concrete slabs left for long time without aerated might lead to breeding areas. Water storage container facilities in or near construction sites provide DEV vectors habitat to bread.

Corrective Measures

- Urban houses and apartment should be designed with adequate light and ventilation.
- Landscaping of the construction plots should be done with better drainage facilities during and after the construction period.
- House owners should be encouraged to prevent mosquito breeding
- Water containers in building construction sites should be covered with tight lid.
- Periodic inspections of buildings during the rainy seasons and immediately after the rain pour.
- Flat roofs with approach ladder or stairs are very essential for inspection.
- Slope roof should be considered if we can not regularly inspect the roofs
- Projected elements of the buildings should be well drained
- Water for curing of concrete slabs should be changed every third day.
- Need regulation for construction sites management especially materials storage facilities and construction waste dumping provision.
- Hollow trees and bamboos should be filled with packed sand, crushed stone or glass.
- Technical corners of high-rise buildings should be equipped with inspection chambers.
- Clear vector breeding sites regularly where construction activities are going on.

6.2.10 Industries and automobile repair centers:

Industries and automobile repair centers produces more discarded receptacles such as automobile tyres, machinery, tin cans, flower vases, bottles, etc. Stagnant water in receptacles serves breeding sites for dengue vectors.

Corrective Measures

- Discarded receptacles that generated from industries and automobile should be properly managed.
- These wastes should be covered.
- Reusing and reduction on generation of these discarded receptacles.

The major environmental management methods used for the control of the immature stages of dengue vectors is summarized in Box 1.

Box 1 : Environmental measures for the control of *Ae. aegypti* production sites

	Environmental measures for the control of Aedes aegypti production site						
Production site	Clean	Cover	Store under roof	Modify design	Fill Sand or soil	Collect/ recycle/dispose	Puncture or drain
Essential							
Water storage tank/cistern	+	+		+			
Drum(40-55)	+	+		+	+		
Flower vase with water	+						
Potted plants with saucers	+						
Ornamental pool/fountain	+						
Roof gutter/sun shades	+						
Minimal water container	+						
Ant trap	+						
Non-essential							
Used tyres		+	+			+	
Discarded large appliances					+	+	
Discarded buckets						+	+
Tin cans						+	+

7 Government Policies related to Dengue Prevention in Nepal

Following are the synopsis of the government policies that explicitly or implicitly address the issues of developing clean, healthy and urban environment that, if systematically implemented, may help implementing the abovementioned corrective measures to reduce or to eradicate the danger of Dengue vectors:

The Tenth Plan (2002-2007): The main objective of the tenth plan is poverty alleviation. The poverty reduction strategy aims to reduce poverty to 30 % by 2007 and significantly improve living condition of the poor. Specific strategies to provide housing facilities to the marginalized groups and to the victims of natural disaster and to develop housing with the involvement of the private sectors have been outlined under urban development. Achievements are: Healthy city program is initiated in 9 municipalities, urban and environmental improvement project ongoing in 8 municipalities; squatter settlement improvement program launched in 3 different settlements, and so on.

***Three Year Interim Plan 2007-2010*:** One of the objectives set forth in the plan is to achieve clean, safe and developed urban environment through investment in urban infrastructure and services development based on inter-service provider agencies coordination. The goal is to achieve 12,000 developed building plots, organize healthy city program in 12 municipalities, detail project report preparation of 40 kms length of proposed outer ring road, periodic plan will be prepared in additional 12 municipalities, initiate 25 numbers of squatters settlement improvement program, repair and maintenance of buildings and heritage sites, detail project preparation of municipal transportation and solid waste management system and so on.

The government has identified the Dengue as one of the emerging new diseases and sanitation, mosquito control and health education programs will be conducted with the help of municipalities.

National Urban Policy - 2007: The second main objective of the policy is to improve the quality of life of urban inhabitants through creation of clean, safe and prosperous urban environment. Among the various strategies to achieve the above mentioned objective, some of them explicitly or implicitly could be interpreted for addressing the issues of eliminating water-born vector-based virus-caused fever like Dengue. These are:

- To encourage and guide local authority to carry out urban development activities according to approved plan,
- To encourage environment friendly public transportation system,

- To develop balanced town and suburb (Tole) through conservation and sustainable use of natural resources and traditional physical structures,
- To develop dense urban settlements with physical facilities by discouraging scattered settlements,
- To identify and utilize possible resource for urban infrastructure development.
- To develop healthy cities by giving priority to environment conservation while executing town development activities and mobilizing natural resources.
- To encourage well facilitated large town and settlements in order to reduce degrading state of natural resources and investment in infrastructure facilities by discouraging development of scattered settlements.
- To establish a system of development and implementation of disaster management plan by local institution to reduce loss of lie and property from likely natural disaster.

Policy and working policy related to abovementioned strategies that are implicitly relevant to the present case are:

- To guide and encourage local bodies to formulate periodic and annual plans and let them execute physical development activities according to the plans
- To make such provisions under which al municipalities could formulate and implement parking policy
- To direct and motivate local authorities to identify uniqueness of inner part of city and to develop and implement land-use planning for conservation and protection thereof
- To establish system for sustainable use of natural resources without causing damage to such sources
- To conserve and protect physical structures like traditional spout, well, springs and canals in towns through community mobilization and implementation of construction related norms.
- To contribute to the supply of water requirement for urban activities through adoption of appropriate collection technology like rainwater harvesting without wasting such natural resources.
- To make necessary policy and legal provisions to carry out urban sanitation and management of solid waste and dirty water in planned and integrated way by local authority.
- To make provisions that enforce a system that local authority is required to conduct environmental and social impact assessment compulsorily while carrying out any physical development activities.
- To establish a system of giving main priority to environmentally clean city during operation of any physical development or urban development activities
- To encourage all municipalities to make and implement special programs on healthy town and also the incorporation of activities within such a program like keeping public-utility places such as school, hospital and Public Parks clean.

- In order to reduce environmental degradation due to scattered settlement development, enforce necessary standards accordingly.
- To develop safe, accessible to general people and environmentally appropriate buildings construction methodology
- To implement National Building Code in governmental, non-governmental public and private buildings.

National Shelter policy 1996 - Revision 2007: The main objective is to develop the concept of shelter for all through increased production of environment friendly shelters. Strategy to achieve above said objective are to increase in housing production along with upgrading of existing housing stock, to increase and develop required physical infrastructure and service facilities, to improve construction technology and building materials in construction.

Dengue Breeding Sites


Rain water collected in a tree hole.

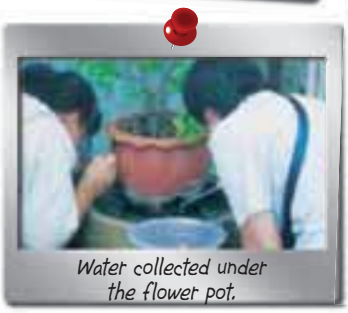

Flower pot with water collection.


Ornamental structure with collected rain water.


Open water container.


Plates used for holding water under flower pots.


Huge water storing container without tight fitting lids and that cannot be emptied easily.


Water collected under the flower pot.


Open tar drums at road construction sites.


Un-open tar drums with depressed lids collecting rain water.


Barrel without lid for water storage.


Example of poor garbage management (Coconut shells with rain water collection).


Over head water storage tanks without properly fitted lids.


Tyres kept out doors collect rain water.


Bamboo stumps used at construction sites and for fencing collecting rain water.

Bibliography

1. Babu, NR., Ashwani, K., 2009. Environmental management plan for Kanpur urban area. Avilable at: http://www.gisdevelopment.net/application/environment/conservation/envm0002pf.htm [Accessed 26 Sept. 2008].
2. DRHD, 2009. Facts about Stagnant water and Mosquito Prevention. Durham Region Health Department, Canada. Avialable at http://www.region.durham.on.ca/ [Accessed 26 Sept. 2008].
3. EDCD, 2007. Epidemiology and Disease Control Division, MOH, Kathmandu Nepal, Annual Report.
4. Gautam, I., Dhimalm, M., Shretha, SR., Tamrakar, AS., 2009. First Record of Aedes Aegypti (L.) Vector of Dengue Virus from Kathmandu, Nepal. *Natural History Museum*, 24, PP. 156-64.
5. NSP, 2064. National Shelter Policy, Government of Nepal (GoN), Ministry of Physical Planning and Works, Department of Urban Development and Building Construction, Babar Mahal (A Draft Report).
6. NUP, 2064. Vision of Balanced National Urban System, National Urban Policy. Government of Nepal (GoN), Ministry of Physical Planning and Works, Department of Urban Development and Building Construction, Babar Mahal.
7. Pandey, BD., Morita, K., Khanal ,S.R., Takasaki, T., Miyazaki I., Inoue, TO., Inoue S, Ichiro K., 2008. Emerging Infectious disease; Dengue virus, Nepal. Avialable at: www.ncbi.nlm.nih.gov/pmc/articles/PMC2570825/ [Accessed 26 Sept. 2008].
8. Pandey, B.D., Igarashi , A., 2000. Severity-related molecular differences among nineteen strains of dengue type 2 viruses, *Microbiol Immunol*, 44, PP.179-88.
9. Sherchand, JB., Pandey, BD., Haruki ,K., Jimba M., 2001. Sero-diagnosis of Japanese encephalitis and dengue virus infection from clinically suspected patients of Nepal *J Inst. Med*. 23, PP.25–31.
10. Urban Environmental Guidelines for Nepal 1992, Urban Development through Local Efforts Project, Federal Republiv of Germany in Cooperation with LUDTC-Local and Urban Development Training Centre, Pokhara, GoN.
11. WHO, 1996. Comprehensive Guidelines for Prevention and Control of Dengue/DHF. World Health Organization Regional Office for South-East Asia (New Delhi): WHO Regional Publication, SEARO No. 29; 1996.

12. WHO, 2003. World Health Organization; The South East Asia and Western Pacific Region. *Dengue Bulletin*, Dec, 27.

13. WHO, 2006. Facts sheet on dengue and haemorrhagic fever. World Health Organization. (online) Available at: www.searo.who.int/en/Section12/Section321/Section1631.htm [Accessed 26 Sept. 2008].

14. WHO, 2007. Situation update of dengue in the SEA Region. World Health Organization. (Online) Available at: http://www.searo.who.int/LinkFiles/Dengue_DengueSEAR-07.pdf [Accessed 23 Sept. 2008].

15. WHO, 2007. Trend of Dengue case and CFR in SEAR Countries-Nepal. The South-East Asia and Western Pacific Region: World Health Organization. (Online) Available at: http://www.searo.who.int/EN/Section10/Section332/Section2277_13402.htm [Accessed 23 Sept. 2008].

16. WHO, 2008. Key facts on Dengue and dengue haemorrhagic fever. World Health Organization [Online] Available at: http://www.who.int/mediacentre/factsheets/fs117/en/ [Accessed 26 Sept. 2008].

17. WHO, 2008. Situation of Dengue/ Dengue Haemorrhagic Fever in South-East Asia Region. World Health Organization (Online) Available at : http://www.searo.who.int/EN/Section10/Section332_1098.htm [Accessed 26 Sept. 2008].

Annex I

Photographs

Poorly constructed and inadequate drainage systems hindrance storm water making them waterlogged

Water Container without Lid

Unpaved and undulated surface with waste water littered

Old and unused tyres usually stacked on the road side

Storage of building materials on the roofs may retain water

Unfinished Chajja may retain water

Waste Collection on the road side

Unclear of Construction Formwork after Buiding Construction

Water logged area near by Residential and Office complexes

Annex II

Participant List

Date: 13 February 2009 Venue: NHRC Conference Hall

S. N.	Name	Address	Phone Number
1.	Dr. Mahesh Kumar Maskey	NHRC	4254220
2.	Dr. Dirgha Singh Bam	MOHP	9851088705
3.	Dr. Gobinda Prasad Ojha	DOHS	9851069528
4.	Dr. Shanker Prasad Shrestha	EDCD	9851035009
5.	Mr. Nam Raj Khatri	WHO	5523000
6.	Dr. Manas Kumar Banarjee	Avian Influenza	9841282932
7.	Dr. Basu Dev Pandey	Teku Hospital	9851065451
8.	Prof. A. S. Tamrakar	TU	9841278748
9.	Dr. Ishan Gautam	TU	9841402667
10.	Ms. Sarita Shrestha Maskey	DUP BC	9841586084
11.	Dr. Deepak Mani Pokhrel	MOA	4211940
12.	Mr. Ajoy Kumar Thakur	TUTH	9841234835
13.	Dr. Bandana Pradhan	TUTH	4410268
14.	Mr. Hira Baral	MOHP	
15.	Dr. Buddha Basnyat	NHRC	9851034187
16.	Dr. Sarita Upadhyay	NHRC	4254220
17.	Dr. Achala Vaidya	NHRC	9851033017
18.	Dr. Kedar Prasad Baral	NHRC	9851060058
19.	Dr. Som Nath Aryal	NMC / NHRC	9851099547
20.	Mr. Meghnath Dhimal	NHRC	4254220
21.	Mr. Bijay Kumar Jha	NHRC	4254220