Eco-bio-social Factors of Vector Density–Developing Effective Approaches to Dengue Control in the Philippines

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INTRODUCTION

Dengue is a disabling, acute infectious disease that is a leading cause of death among children in Southeast Asia. In the language used to describe how it is transmitted, a "vector," or an organism that can carry a disease-causing agent (i.e. a virus) without itself succumbing to the disease, passes on this agent to a "host," or a living being (such as humans) that can be infected by the disease. This study, thus, looks into factors that contribute to sustaining vectors and how they can be managed to decrease the incidence of dengue in the Philippines. In the first phase of the study, it sought specifically to describe the ecosystem, vector ecology, socio-behavioral context and vector control programmes and activities; to analyze the relative importance of eco-bio-social factors associated with different levels of vector density; and to identify the interventions appropriate to the ecosystem under study. The interventions identified will be implemented in Phase 2 of the study.

Funded by the World Health Organization/TDR, the study was participated in by three collaborating institutions: the Research Institute for Tropical Medicine in Muntinlupa City, De La Salle University, Manila; and the Infectious Diseases Office of the National Communicable Disease Control Program, Manila. They utilized a selective, inter-sectoral approach to dengue vector control aimed at epidemiologically important key containers identified by pupa surveys, and applied during critical periods of dengue transmission. It was expected that such an approach could result in long-term source reduction and effective dengue control in the Philippines.

Two entomological surveys on households selected by cluster sampling were made. The first was conducted during the rainy season (September to November 2007), and the second was during the dry season (April 2008). The data for estimating pupa/person index, and for the socio-behavioral component, was collected from households as follows:

a) through knowledge, attitudes, practice (KAP) and demography surveys of households in the first entomological survey; b) through focus group discussions (FGDs) and key informant interviews (KII); and c) through analysis of influence of gender on dengue risk and exposure, water domestic water management and usage, pest control, and waste disposal. Local vector control activities were observed during these two periods; interviews were made with key control program and local government officials and personnel. A temporal and geographical representation of vector density, socio-behavioral factors, and vector control activities was constructed. Lastly, crude analysis of the eco-bio-social model of pupal abundance was presented to communities in which the surveys were conducted.

Simultaneous with the first entomological survey, a KAP survey of about 1200 randomly selected household heads was conducted. Topics covered were dengue transmission, prevention, and practices for control. Observations of household practices among selected households for water collection, usage, and storage were made. A combination of open-ended, semi-structured interviews with health and local barangay officials and dengue control program field personnel, together with observations of dengue control activities, enabled the researchers to identify control program strategies and actual practices, as well as frequency of control activities and coverage among the barangays. Interviews with city health and political officials were conducted to define decision-making processes regarding program operations, and also included discussions on the programs' constraints and how the officials would evaluate the said programs.

The ***project site*** for the first phase of the study was Muntinlupa City, one of the 17 cities of the National Capital Region (NCR) of the Philippines. The city is located along the western banks of Laguna Lake and south of the metropolitan Manila area. The seasons in this area are wet and dry. In 2007, the average range of temperature, relative humidity and total rainfall was 26 to 33C, 73.3%, and 1,965 mm, respectively. It is a fast-growing city with a population of almost half a million, and a density of 9,568 per km2 in 2005. It is composed of 10 barangays (villages) and has industrial, commercial, and residential areas. Some of the residential areas are temporary dwellings for migrants from rural areas, and mobile population from other urbanized areas in metropolitan Manila. It has active health referral and surveillance systems for dengue among its primary, secondary and tertiary health care facilities. Dengue has been reported in the city fore more than 20 years. The dengue incidence in 2007 was 184.6 per 100,000 population. From January to April 2008, there were 3,798 reported cases of dengue in NCR sentinel hospitals; this was 165% more than cases reported during the same period in 2007. In Muntinlupa there were 182 cases reported; this was three times more than the same period in the previous year.

Selection of barangays in Muntinlupa were based on rank according to mean dengue incidence from 2003 to 2005. The barangays were defined as either high or low incidence for dengue if the mean dengue incidence was either above or below, respectively, that of Muntinlupa (70.1/100,000 population). One high incidence (Putatan) and one low incidence (Buli-Cupang) barangay were selected.

With regard to ***map preparation,*** the polygon shapefile of the selected study sites, Buli/Cupang and Putatan, were exported from ArcGIS 9.1 to a Google Earth KML file using free software called KML Home Companion 3.1 and was superimposed on Google Earth (Free) 4.0.2327. Based on the information from Google Earth via Digital Globe's coverage layer information, the first acquisition date of the image, which included Muntinlupa City, was on March 2002; the latest acquisition during the period the study map was constructed (July 2007) was January 2007. Multiple screenshots of the study sites from the East to the West boundaries were taken from an altitude of 693 metres and were reconstructed using an imaging program. The reconstructed image was then geo-referenced in ArcGIS 9.1. A 100m X 100m (1 hectare) grid was drawn using the North American Datum of 1927 as reference and coordinate system. The coordinates of several known landmarks from the image in ArcGIS 9.1 were plotted on Google Earth (Free) to verify the accuracy of the ArcGIS geo-referencing procedure. The ArcGIS maps were printed on several sheets of paper and pieced together to form a huge 60 x 42 inch and 52 x 38 inch map of barangays Buli/Cupang and Putatan, respectively. These printed maps were used for cluster identification and classification.

In ***cluster selection,*** clusters (1 hectare grids) were arbitrarily classified into high and low populated areas based on the amount of visible green/open areas. Clusters near or adjacent to a highway or railroad were excluded from the classification because of the anticipated difficulties and risk during surveys. With the use of EpiInfo 6D's Epitable Random Number List, the clusters were listed into two groups. Three high densely as well as three low densely populated clusters per barangay were randomly nominated and were marked in the published map. Their locations were georeferenced on the ground as well as identified with the help of the local health office. On the ground, inspection of the clusters was done to confirm the identification of the nominated cluster as well as to verify the classification by population density. Letters soliciting consent were sent to the community leaders of the clusters. If consent was not obtained, the cluster was replaced by another randomly nominated cluster. The geographic coordinates of the four corners of the nominated clusters were recorded and were uploaded to the GPS unit using MapSource® version 6.12.4. The GPS unit used was Garmin GPS 76, which according to the manufacturer, has a GPS and WAAS accuracy of $<$15 metres and $<$3 metres, respectively. The coordinates were also exported to Google Earth (Free) for future reference. The coordinates of the cluster were georeferenced by the project team together with the local Barangay Health Workers (BHW). The corners of the cluster were marked by placing a colored sticker on the nearest landmark. During georeferencing, the allowed accuracy of the GPS was within 8 metres. Some of the clusters have houses built or packed so close to each other that there was too little to no visible sky for the GPS signal transmission.

In this situation, the GPS referencing of the corners were made on the nearest accessible opening with sky visibility.

Household selection was done from a list in each cluster that was obtained from the residents or from the village association office. The list was numbered according to the cluster for random selection. At least 100 randomly nominated households per cluster were chosen for the KAP and entomological survey. For clusters that had less than 100 households, all the households were included in the survey, and adjacent grids were added in a clockwise direction starting from the cluster above until at least 100 household/houses were achieved for survey. For grids (cells) including the spills with less than 100 household/houses, every household in that community was included in the survey. Only the households that consented and signed the respective form were georeferenced and surveyed. Households that refused to participate were replaced with the next and nearest household in the random list that was not included in the initial selection. A repeat of georeferencing was done on the surveyed households in each of the clusters of Barangay Putatan to correct the errors of coordinates.

A three-day ***staff training*** on pupal survey and KAP survey was conducted for all 10 full-time research assistants (RAs) and 10 barangay health workers (BHWs) from the city health office. Laboratory and field practicum were also held.

PUPAL SURVEY IN HOUSEHOLDS AND PUBLIC SPACES

The Entomological Survey Teams. The RAs and BHWs formed five survey teams. The team leader's responsibilities were to lead the team during the actual survey, secure the supplies needed for the survey, and report the incidences that happened on a particular working day. Each team was assigned to survey 20-25 households per cluster and was equipped with the following: handheld GPS receiver, pail, basin, tape measure, retractable meter stick, graduated plastic tubes, graduated plastic pitcher, and fish sweep nets (large and small). The list of households surveyed was then updated and the team leader reported experiences on the field. The inventory of the supplies was then checked and replenished for the following day's survey.

Household locating and geo-referencing. Each house was geo-referenced with a Garmin® GPS 76 Handheld Navigator. A neon-colored sticker bearing the assigned household number was then placed strategically on the front of the house to mark the household for future reference.

Obtaining informed consent. Before the start of each entomological survey, the team was introduced and the purpose of their visit was given. The information sheet for the informed consent for the survey was then read and explained by the team leader. The two copies of the informed consent were signed both by the household member and either by the team leader or a team member. One copy was given to the household member while the team leader kept the other.

Measuring the capacity volume of and volume of water in the containers. All water-holding containers, including those that are commercially produced, improvised, neglected, or those that could be categorized as naturally occurring or accidental water-bearing containers were inspected. The specified volume of the commercial products such as soda bottles was noted. Similarly, for non-commercial products with no specified capacity volume, the particular container's dimensions were measured using a tape measure or a retractable meter stick to obtain its capacity volume. The height and diameter of cylindrical containers were measured to supply the needed variables for the formula of a cylinder, $V_c = \Pi r^2 h$. For containers with the shape of a pail, the average of the top and bottom diameters was regarded as the diameter of the container.

Similarly, the length, width, and the height of a box-like container was measured and computed following the formula, $V_b = lwh$. For containers with a relatively small amount of water, the water was poured into a graduated pitcher and the volume recorded.

The type and description of the container, use of the water in the container, the type of the water contained, presence of vegetation in the water, location of the container, shading, control intervention made on the water, and the container covering were inquired about and investigated. All the containers were inspected according to the information required on the official entomological survey form. If no water-bearing container was found, remarks on the house were recorded on the entomological survey form as such.

Determination of the Larval and Pupal Counts. The water in each container was inspected for mosquito larvae and pupae. When present, the specimens were collected using the supplied sweep nets, and transferred to a basin with water for better inspection. For large containers (120-liter capacity volume and above), the Five-Sweep Netting Technique (Knox, et al., 2007) was utilized. The larval count was estimated and then coded for a particular range: "0" for none, "1" for less than ten, "2" for ten to fifty, and "3" for more than fifty. The pupal count was estimated using the five-sweep method corrected with the formula n= pupal count/0.2046.

Specimen transport. From the basin and with the use of a pipette, larva and pupa from each container were transferred to separate plastic bags with clean water. The plastic bag was labeled with cluster name, household number (if applicable), container number, specimen (i.e., whether pupa or larva), date of collection, and collector's name. Each plastic container was slip-knot tied at the open end, making sure that there was at least 30-50% of airspace in the sealed plastic container. All collected specimens were carried in a pail and submitted to the entomology laboratory in the afternoon. At the laboratory, the specimens were turned over by the inspectors to the designated Entomologist.

Public spaces. All public spaces in the clusters were inspected for water holding containers. Pupa surveys were also conducted in buildings such as multipurpose halls and churches. The procedures for computing volume and actual water volume, specimen collection and estimating the number of larva and pupa were similar to those for the households.

Identification of emerged adults in the laboratory. Larvae and pupae were transferred in separate styrofoam cups. Each cup was labeled with the following format wherever applicable: Cluster Name: Household No., Date Collected, Collector's name, Contents (Pupae/Larvae), Container number. The specimens were allowed to continue development until observed to be adults. Food supplements were not given. The cups were kept in trays according to date of collection and cluster. These were kept in the laboratory with temperature maintained at 25°C by airconditioning during weekdays; however, the airconditioner was turned off during the weekends.

Cups were inspected daily for adults. The adult specimen were retrieved with the use of a sucking tube and were identified (*Aedes aegypti*, *Aedes albopictus* and *Culex or Armigeres* sp.) through inspection under a stereomicroscope. The species identification were recorded in prepared data sheets. The recorded data were household number and/or type of public space where the specimens (larvae and pupae) were collected. Male and female emergence for *Aedes* vectors were listed separately. The adult vector were killed by freezing and transferred into cryotubes and stored in deep freeze. Records were updated daily for adult vector identified either from larval or pupal collections. Observations of adult vector emergence were made from 10 September to 21 December 2007.

Pre testing of questionnaire. The standard KAP questionnaire was pre-tested in households in non-selected barangays of Muntinlupa. The results of the pre-testing were shared during the Community of Practice last June 2007. The final standardized KAP questionnaire was translated into Filipino and an operating manual was developed. Research assistants and selected Barangay Health Workers were trained on the use of the interview schedule through lectures, mock interviews and a field practicum.

Household KAP Survey. The same individuals who performed the pupal survey carried out the KAP survey. Informed consent was obtained from the household head or appropriate person before the KAP was interview was conducted. For the first 3 weeks, the KAP survey was simultaneously conducted with the entomological survey. However, it was observed that the entomological survey took 10-15 minutes while the KAP survey took 20-30 minutes to complete. Thus, the targeted number of households surveyed each day was reached. The entomological survey was completed first; research assistants and/or BHWs revisited the households that were not interviewed for KAP. Unfortunately, refusals were encountered; these households were not replaced because they had already participated in the pupal survey.

Observation of Households. One hundred seventy-three of the 1,200 households randomly sampled for the pupal and KAP surveys were observed using an observation guide/checklist as to presence of water containers; kind and state of water containers; presence of possible breeding sites; water storage, sanitation and waste disposal practices; and elimination of breeding sites. The households for observation were chosen through convenience sampling.

Key-Informant Interviews. After the possible Key-Informants were identified, letters were distributed to each of them to obtain their consent to be interviewed. The KIs of the study were selected through purposive and referral sampling. They were chosen by virtue of the expertise they have regarding the subject matter. There were 12 key-informants 10 were service providers from the local government and barangay, while the other two were from the community. The KIs for the study consisted of the Program Manager for Dengue and Emerging Diseases, City Health Officials, Barangay Captains of two barangays (Cupang and Putatan) which served as the research sites, Presidents of two subdivisions (Intercity Homes and San Jose Village), President of the Barangay Health Workers (BHWs) Association, and individuals from other government agencies such as the Planning Department of the City Government and the Environmental Sanitation Center. The topics discussed during the KI interviews ranged from the existence of a dengue vector control program; its objectives, activities, and roles and responsibilities of key personnel; funding, networking and capacity-building activities; as well as provision of services such as water, garbage collection and sanitation. The key-informants were also asked about any problem or difficulty they encountered in implementing dengue-related activities and how these were managed. Suggestions were also solicited as to how the vector control program could become a success in the future.

Focus Group Discussion. On the other hand, the respondents for the FGDs were invited through coordination with the President of the BHW Association, the BHWs assigned to barangays Putatan, Buli and Cupang as well as the different School Superintendents and respective Principals. The respondents for the FGDs were also selected through purposive sampling. The following criteria were used for selecting the respondents: 1) they should be residing areas falling under the four divisions of the research sites high population, high dengue incidence; low population, high dengue incidence; high population, low dengue incidence; and low population, low dengue incidence barangays; and 2) they should not be included in the KAP/entomological survey. In all there were 10 focus group discussions (FGDs) that were undertaken, as presented in Table 2. The researchers conducted four FGDs with 35 Barangay Health Workers (BHWs), two FGDs with 21 school teachers, and four FGDs with 34 mothers. In the four FGDs with the barangay health workers (BHWs), two were conducted with those assigned in Barangay Putatan (one group from a high population and another group from a low population cluster) and two with those from Barangay Buli and Cupang (one group from a high population and another group from a low population cluster). Eleven participants in the FGDs with school teachers were from schools located in Barangay Putatan. These schools were comprised of Putatan Elementary School, Lakeview Elementary School, Muntinlupa Cosmopolitan School and Muntinlupa Institute of Technology. Ten (10) respondents were from Cupang Elementary School and Lady of the Lake School, both found in Barangay Cupang. It was ensured that each group had a representative from the public and private schools in the area.

Cluster background survey. The clusters were inspected on foot and via motorcycle with sidecar. The motorcycle with sidecar was used to inspect immediate surrounding areas and those within 500 meters of the cluster (e.g. presence of lakes, puddles, vegetative land cover, tire capping facilities). The main roads in the cluster were traversed by foot to observe socio-economic conditions (such as housing structure, residential function, type of houses), distance between houses, gardens, green areas, garbage dumping areas, pools of water, the cluster infrastructure (e.g. water supply, electricity, roads), public spaces (e.g. schools, religious sites, markets, railway, cemetery, ferry, health facilities), vector control measures done, community work, vegetation, tire capping, and general topography of the clusters. Smaller roads were also traversed on foot. Where needed, the information for the cluster background survey (e.g. community activities, areas prone to floods, meetings, vector control) was collected through interviews with the homeowners' association and local leaders and officials.

Data management. All forms that were gathered during the survey were reviewed for inconsistency, illegibility as well as missing entries before the data was encoded in EpiInfo 6D. Forms or households with missing, inconsistent or illegible data were retrieved by the editor and re-assessed by the same survey interviewer during the next survey date. Four separate databases were used in encoding data: household KAP survey; household entomological survey; public space entomological survey, and cluster background. Coding of data was done using a standard coding manual and encoded twice by two individuals using two identical databases. These databases were exported to a dbf file for sorting of the records according to household ID number as well as container number (for entomological survey) and imported back to EpiInfo 6D format for validation. The databases were validated against each other with regard to the number of records and recorded data per variable available. The data was edited and updated based on the information on the actual survey form. Validation of KAP encoded data excluded the name spellings of the household head, respondent and household members.

RESULTS

I. Ecological

Density of population and green areas. The households in the selected clusters were similar with regard to residential function and types. Except for Pasong Makipot, Bagong Sibol and Manggahan, all had defined public spaces for leisure activities. The most common were basketball courts and multi-purpose halls. Tides flood the clusters along the lake shore (*Purok* 6, *Purok* 4 and *Purok* 1) during the rainy season. Portions of San Jose Village also flood during rainy season. This cluster was the only one observed to have garbage in the public spaces.

The socio-economic characteristics of the population, housing condition and mean distance between houses were similar among the clusters within the classification by density of houses. The households in high density clusters were in the lower middle and lowest strata. Informal settlers (i.e. those who squat on the land) were present in all but one cluster (*Purok* 4). Twenty to 40% of houses were in poor condition; the rest were satisfactory. The mean distance between the houses ranged from less than one meter apart to 1 to 3 meters (between rows of houses or when streets separate the houses). Except for *Purok* 1, which had open green spaces, gardens were either absent or limited to less than 10% of the cluster.

The households in the low density clusters mostly belonged to the upper middle strata. A majority had good housing conditions. Twenty percent of the households in Lakeview were informal settlers whose housing conditions were either satisfactory or poor. The distance between houses was at least 3 meters. The townhouses, because of their structure, were from 1 to 2 meters apart. Vacant residential lots were common in four clusters, particularly San Jose Village. Except for Agro Homes/Bliss (Bliss is tenement housing), more than 50% of homes in these clusters have gardens.

Basic infrastructure and utilities. Electricity is available to almost all households; however, the connections are mostly illegal in four of the high-density clusters. Most roads are paved; solid waste disposal is regular (some daily); and a tire-capping facility is found in Rizal/Mintcor Townhouses and Purok 1.

Some characteristics were similar among the high- and low-density clusters. In the high-density clusters water supply is not adequate. Very few homes in two clusters and none in two others had piped water supply. Most homes in *Purok* 1 and *Purok* 6 have piped water supply but the supply is not adequate. Households purchase water from a distributor (water truck) supplied either privately or by the city government. A public faucet is available in *Purok* 6. Although most of the homes in the low density cluster had piped water supply, the supply was not adequate; most homes had deep wells that supplied water through a motorized pump.

Public spaces. Schools are present in all clusters; religious sites are found in all but two clusters (Pasong Makipot and Purok 6). Invariably present in the clusters are small public markets, public and private health facilities and car service stations. Cemeteries, jetties, cinemas and theater halls, and commercial malls are absent in the clusters.

Recent vector control activities. Fogging by the city government was carried out in the past six months in Manggahan, Agro Homes, and San Jose Subdivision because of a request from the households.

Community activities. The most common community activity is cleanliness drives carried out by the youth and hired street sweepers. Meetings of homeowners are a common regular activity. Residents of Manggahan and Bagong Sibol hold meetings to discuss land rights and ownership.

Adjacent areas. The immediate areas of the clusters were other residences, vacant lots with greens, highways and factories. Within 500 meters were the lakeshore for Purok 6, Purok 4 and Purok 1; a garbage dump in Pasong Makipot, Manggahan, Lakeview Homes and San Jose Village; and a tire-capping facility in Purok 1 and Rizal/Mintcor. All clusters except Purok 1 have vegetative land cover and more shaded areas.

II. Biological

Pupal/larval productivity data in households (private spaces) and public spaces in the selected clusters

A. Rainy season (September November 2007)

More than 11 percent (11.6%) of the 1,231 households surveyed had water-holding containers with pupa. Pupa were observed in 275 (or 11%) of the 2,454 water-holding containers in the private and public spaces. The pupa per person indices (PPI) ranged from 0.03 (Agro homes/Bliss) to 0.94 (Manggahan); the overall mean for the twelve clusters was 0.27. *Aedes aegypti* was the dominant vector for all clusters with mean pupae/positive container of 11.1. *Aedes albopictus* was observed from pupa reared from clusters identified to have low dengue incidence and low density such as San Jose Village, Mintcor-Rizal and Intercity. This species was observed in only one cluster with reported high dengue incidence (Mutual Homes). Eighty-seven percent of water-holding containers with pupa were found in private spaces. Although only 5% of water holding containers was observed in the public spaces, the proportion of these containers with pupa was higher (36 of 134 or 37%); 10% of the water-holding containers in private spaces had pupa. Water-holding drums and tires that were filled with rain water, partially covered by overhanging vegetation and roofs, partially covered by a lid, located outdoors and with water used for less than a weekly basis, were significantly more likely to contain higher pupa counts than other container characteristics. Although only two coconut shells were observed in the open spaces, these had significantly higher pupal counts than the rest of the containers (34.5 vs. 1.41).

1. ***Key containers - private spaces***
   Overall, the key containers were drums (61.7%), others category (14%) and discarded tires (7%). Containers in the

others category varied, including discarded items (jar, pot, pot cover, plastic plate, plate trays, drum cover, dipper, flower pot, Styrofoam ice box) and trash (plastic mineral water containers, basketball ring stand, rolled canvass). These also included dish racks found in kitchens and one fountain in a garden. Seventy-three of the 881 drums containing water were observed to contain pupa; 92% (or 67) of the drums were used for household purposes. Among the clusters, variations in key container categories were observed. For instance, within the low dengue incidence group, Rizal-Mintcor had tires (41%) as a key container. In another cluster, Intercity Homes, key containers were the others category (45%; plate, water dipper and fountain). Agrohomes-Bliss is a cluster with high dengue incidence and low density; flower vases were key containers (48%) followed by those in the others category (38%).

2. Key containers - public spaces

Tires (41%) were the overall key container. This was followed by the Others category (15%) and coconut shells (12%). Among the clusters, flower vases in Rizal-Mintcor, buckets in Mutual Homes, coconut shells in Agrohomes-Bliss clusters, bowls in Pasong Makipot, and containers under the Others category (consisting of cracks from concrete cement and a discarded hat) in Purok-6 key containers.

3. Levels of pupa density

The mean pupa per person index (PPI) of the 12 clusters was 0.27; the median pupa per person was 0.22. The pupa observed pupa in public spaces were included in these estimates. Values equal to or less than the median were considered to have low PPI; those above this value were considered to have high PPI. The clusters with high PPI were: Manggahan, San Jose, Pasong Makipot, Intercity Homes and

Mutual Homes. San Jose, Mintcor-Rizal and Intercity Homes are clusters in the barangay with reported low dengue incidence; the households in these clusters were ranked as mostly upper middle class, and as seen from an aerial view, are less crowded compared to the others. Except for Mintcor-Rizal, the number of water-holding containers in these clusters was equal to that in the high dengue incidence and high density clusters.

B. Dry season (April 2008)

Six clusters were selected for entomological survey during the dry season: Pasong Makipot, Manggahan, Mutual Homes, Purok 6, San Jose Village and Intercity Homes. Except for Purok 6, all had PPI above the median estimate in 2007. Twenty-two (4%) of the 541 houses surveyed had water-holding containers that were positive for pupa; seven of these households also had pupa positive water-holding containers in 2007. A total of 1,783 water-holding containers were counted and 24 (1.3%) had pupa. The PPI during this period was 0.09. Ninety-six percent of the emerged adults were *Aedes aegypti*; *Aedes albopictus* emerged in pupa collected from San Jose village. During this season, containers with rain water, partially shaded, partially covered with a lid, and with water contents not used for less than a weekly basis significantly had higher pupa counts than other water-holding containers.

1. ***Key containers in private spaces***
   Twenty-four (1.3%) containers were found to have pupa. The key containers were drums and pails; the water was used for household purposes.

2. ***Key containers in public spaces.***
   Fourteen water-holding containers were found in the public spaces of three clusters. There were five drums in Intercity Homes that

were used in the construction of a church. In Pasong Makipot, the caretaker was utilizing the five pails in the day care center. The three drums in the San Jose clubhouse were used for watering plants. Only one container had pupa; this was one of the drums inspected in Intercity Homes.

C. Containers in private and public spaces - rainy versus dry season

In the six clusters surveyed during the two seasons, the proportion of houses with water-holding containers positive for pupa in the private spaces was significantly higher during the rainy season (17.1 vs. 4.1%) compared to the dry season. Although there were 23% more water-holding containers during the dry season compared to the rainy season in the six clusters surveyed during these two periods, the proportion of water-holding containers with pupa was significantly higher during the latter season (17.1% vs 6.9%). The pupa per person index of these six clusters during this period was significantly lower in the dry season than that during the rainy season ($p < 0.006$). The contribution of water-holding containers in public spaces to potential dengue transmission was more important during the rainy season than during the dry season. In addition to being more numerous, the containers with pupa during the former were discarded items (i.e., trash); containers during the latter were intentionally filled with water that was used for various reasons.

III. Social

A. KAP survey

There were 1,114 respondents for the survey. The mean number of years of residence in Muntinlupa (25.5 to 30.6 years) was highest for respondents living in the clusters along the shores of Laguna lake (*Purok* 1, *Purok* 4 and *Purok* 6). Bagong Sibol (Tagalog for 'just sprouting') residents have lived in their community for a mean of nine years. Seven hundred forty-six residents (65%) considered themselves as knowledgeable about dengue. For 88% of these households, television was the main source of information on dengue. Seventy to 100% of these households said that a mosquito transmitted dengue and 63% considered dengue to be preventable. There was no significant difference in these proportions among the households in the 12 clusters. For all the respondents except those in *Purok* 4, clean-, dirty- and any water condition were invariably selected as sites were mosquitoes breed. Interestingly, only one household in *Purok* 4 mentioned clean water as a breeding site of dengue transmitting mosquitoes (the pupa per person index in this cluster was 0.03, the lowest among the clusters). Disposing of garbage, covering water-holding containers with lids, and indoor insecticide spraying were selected as common household measures to reduce the number of dengue mosquitoes. More than half of the households in the clusters participated in environment cleaning activities; elimination of breeding places was the most common activity selected during the interviews. Similarly, garbage disposal, eliminating stagnant water, and cleaning and covering water-holding containers were identified as activities households practice to prevent mosquito breeding. Fogging, educating people on dengue and inspecting water-holding containers were identified as activities the government can do to support dengue control. Garbage collection and dumping garbage in specific sites (particularly for Manggahan 64%) were the two most common means of waste management in the three clusters in *barangay* Putatan. Garbage was collected regularly for 67% of the rest of the households. Except for Bagong Sibol (where the proportion was 40%), less than 23% of the households received any information regarding dengue control from health officials; more than 50% of all households could not recall ever being visited by local health personnel. Fifty-eight percent of households surveyed said that there are community efforts to clean the environment. In relation to this, the most common activity the community does to rid itself of the dengue mosquito is elimination of mosquito breeding places. Except for Mutual Homes in *barangay* Putatan, the bore well was the main source of water supply of the interviewed households (see also Cluster Background Survey). Mutual Homes is a private residential area; it is one of two clusters (the other being *Purok* 1) whose water source is from a national private water utility. Despite this, 81% of the households store water. More than 89% of the households from the clusters were identified to have high dengue incidence and high density stored water. More than 50% of the households interviewed from private residential areas, Intercity Homes (67%) and San Jose Village (87%) also store water. For all households, the stored water was used mainly for washing, bathing and cleaning.

B. Interviews

City water supply. According to the Planning Officer of the city government, the majority of the city's population resides in the eastern side of the city and along the shores of Laguna lake. Most of the basic facilities in these "informal settlement areas" are inadequate, particularly water supply and waste disposal. A concessionaire supplies only 5% of Muntinlupa residents in public residential areas with water. The rest receive their water supply through the Free Delivery Water Program. Under this program, private donors and deep wells and pumping stations augment their water supply. Aside from water supply, sanitation and waste disposal services are likewise inadequate, particularly in the depressed areas along the railways, since the garbage trucks cannot reach these parts of the city as often as possible.

City dengue control program. The Department of Health is responsible for coming up with guidelines, policies and recommendations for the national dengue control program. The city governments implement these depending on the priority of the local chief executive. The thrust of the program is advocacy for dengue control through capacity building, training, and IEC and media campaigns. During the time of the interviews, all city health officials said there was no existing dengue vector control program. There are no budget and personnel for dengue control; dengue control is one of the many activities of the sanitary inspectors. The budget for thee activities is taken from the city sanitation budget. The health center nurses give lectures on dengue during the rainy season. Clean-up drives and information dissemination campaigns are irregularly carried out. Spraying of houses and surroundings (fogging) are carried out during the election period. However, in April 2008, a city dengue task force was created (this was also done in other cities in the National Capital Region).

Dengue Control Coordinator of the National Capital Region (NCR). The coordinator has been working in this position for 10 years. The difficulties she faces as the dengue control coordinator for NCR are community and local government indifference to dengue, and poor implementation of control activities by local governments. In response, the coordinator developed guidelines for *Aedes sp.* surveillance. The guidelines include operations and composition of a surveillance team (local dengue control program manager, sanitary officer, health educator and promotions officer). A KAP survey in Manila three years ago disclosed that the participants are knowledgeable about dengue but behavioural change difficult; hence, the coordinator does not agree with the COMBI strategy. Facilitating factors to improve dengue control are: commitment of local governments (particularly *barangay* officials), adequate human resources, community mobilization, and improved IEC materials.

C. Gender and Dengue Control

Data shows that dengue control at the **community** and **household** levels remains gendered. Muntinlupa City consists of nine (9) *barangays*, eight of which have male *barangay* captains and only one (1) is female. The captain heads and represents the *barangay* in the political arena and other public affairs. At the community level, there are 373 *barangay* health workers (BHWs), out of which only three (3) are male. BHWs are the most accessible health service providers for community residents. BHWs are seen as the workhorses in the community they are in charge of a variety of health activities from immunization, nutrition, primary health care, disease prevention, and family planning to health information campaigns, mothers' classes, etc. In the study, all the 35 BHWs who participated in the focus group discussions are female. This supports the dichotomy that describes the locus of female and male activities, that is, males are in the public sphere and are typically spokespersons/leaders while females are relegated to the private sphere and perform vital tasks that hold the social fabric in the community together.

At the household level, data show that dengue control and prevention is generally a female role and concern. Dengue control and prevention at the household level involves activities that are seen as subsistence-related tasks; thus, they are charged to women. When asked about cleaning the house and its surroundings, common responses are, "*Of course, we, the mothers do the cleaning. The men/husbands only sleep. They do not like to clean*." And "*We women have no choice. It is just that way. It will be harder if he volunteers to clean because if it's them (men), I will have to inspect it after. I might just curse him. He says that he wants to clean but he has to earn the whole day, too. He wants the house clean but he will not do the cleaning.*"

Even with regard to water practices, it is still women who are expected to do the tasks. One mother remarked: "*The expectation in this house is I do everything since I am here the whole day. It is not practical to wait for my husband or child to fetch water, throw the garbage when they get home. It is my obligation plus the cooking and cleaning. I do whatever needs to be done in the house*."

While there are a few who acknowledged that their husbands and sons choose to fetch, store water, and bring the garbage out, most mothers narrate the same activities without much complaint. They are resigned to do the tasks which they say are "givens," being household managers. For those who are lucky to have husbands and/or sons that help in the household, they just profusely appreciate it. The research, thus, affirms the lead role women play in maintaining the household welfare. The household well-being is largely sustained by means of work that the women do, which is unpaid. Hence, in activities that directly or indirectly prevent the occurrence of dengue in the household (e.g., cleaning, water management), it is the women who are accountable.

D. Cluster feedback (January to February 2008)

Results of the entomological and KAP surveys were presented to households of the 12 clusters. Prior to this, letters of invitation were sent to the homeowners' association officers and barangay officials; the receipt of the invitation was documented. There were mixed reactions to the results. Community residents were surprised by the results of the survey and asked numerous questions. Officers of the homeowners association requested the names of households whose water-holding containers had pupa (the research team turned down this request); one group demanded that the results should have been presented immediately after the survey. There was a request for seminars and reading materials on dengue. It was also observed that the attendees at the meetings seemed to be more interested in the results of the KAP survey rather than the pupa survey. In the ensuing discussions, frustrations with the control efforts of the Department of Health and City Health Office were expressed. Comments on the election period being the only time barangay officials are visible were raised. The BHWs expressed their frustration that community members participated in health-related activities only when incentives were distributed. The research team was advised that this was an important way to get community involvement. Although community residents insisted that meetings were valuable in disseminating health information, the BHWs countered that it is difficult to get community members to attend these meetings.

Meetings with community members to present the results of the entomological and KAP surveys provided the opportunity to observe community dynamics. The sanitary inspectors and local health personnel of the barangays and clusters attended the meetings; however, they were observed to either arrive late or leave before the meeting ended. In Rizal/Mintcor, the household association officer with whom the team had been in contact regarding arrangements failed to inform anyone about the meeting that was to be held in the chapel. The caretaker of the chapel quickly assembled a group to attend the meeting. In Bagong Sibol, one community member remarked that the BHWs do not visit their homes. A BHW who was present denied this; an argument ensued. BHWs disclosed to the research team that they are not well-received by households in the private residential areas, and feel that their capabilities as primary health providers are doubted.

Politics also polarized the community and two groups were observed to be influential in the community: the homeowners' association and *barangay* officials. During most of the meetings, it was observed that either group was present. BHWs who assisted in the entomological and KAP surveys were the only attendees of *Purok* 6; no barangay official was present. One reason for this, the research team was told, was because the officials were of a different political party. In Pasong Makipot, the homeowners's association official was upset because no *barangay* official came forward to assist in preparing the venue for the meeting. The team was denied the use of the *barangay* hall; the meeting was held in the home an official of the homeowner's association. In Lakeview Homes, no *barangay* official attended the meeting; the leader of an organization of illegal settlers offered the use of his home. It was only in Purok 1 that a local government official attended the meeting: this was the *barangay* secretary for health (*kagawad ng kalusugan ng barangay Cupang*). The community members at the meeting praised the *barangay* official. During this meeting, it was learned that this official had initiated a drive in December 2007 to clean canals with the aim of controlling vector-breeding sites.

FINDINGS

The findings of the entomological and KAP surveys during rainy and dry seasons, and feedback from KIIs and FGDs, support selective, inter-sectoral approaches to dengue vector control aimed at epidemiologically important key containers. The main assumption in Phase I was that the ecological, biological and social factors in Muntinlupa City affect dengue vector density (measured by PPI). This was then the reason for stratifying the areas for cluster selection by reported dengue incidence and crowding: pupa density is higher in areas where more dengue cases are reported and where there is crowding of building structures (i.e. houses). But the entomological surveys rendered unexpected results, particularly in clusters characterized as having low dengue incidence and being relatively less crowded than the other clusters.

The pupa survey during the rainy season revealed that PPI in San Jose Subdivision, Mintcor-Rizal, and Intercity Homes were above the median. These values were higher than those of clusters with higher dengue incidence. In addition, more than half of the water-holding containers inspected in public spaces of San Jose Subdivision and Intercity Homes contained pupa. The former had the highest house index (for pupa) in addition to having the second highest PPI among the 12 clusters. Despite the large number of water-holding containers during each season, the proportion of containers with pupa in all clusters was small. During the rainy and dry seasons, key containers (drums, tires and pails) with any of the following characteristics tended to have higher pupa counts compared to other containers: a) rain water; b) contents used for less than a weekly basis; and c) during the rainy season, located outdoors (i.e. public spaces).

SUMMARY AND RECOMMENDATIONS

The findings of Phase I show that the approach to dengue vector control in Muntinlupa city is complex. There are focal hotspots in the clusters for pupa positive water-holding containers. There are also seasonal differences in number of water-holding containers with pupa, location of these containers, and pupa per person index. Furthermore, during the rainy season, the distribution of houses with water-holding containers is skewed (San Jose Village and drums, respectively). The contribution of water-holding containers in public spaces to pupa productivity during the rainy season is also important.

Though the description of the background of the clusters stratified by dengue incidence and aerial density is similar, the PPI of the clusters within these sub-groups differ. Fortunately, the patterns of responses to KAP are similar in all clusters; however, this will not guarantee a predictable involvement in, and response to, dengue control interventions.

Lastly, community observations underscore the ***need for consensus building*** (e.g. stakeholder analysis) as part of control strategies.

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