The utility GPS/GIS technology in the guidance of targeted interventions
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1. Study Purpose and Rationale

Geographic information systems with global positioning systems have become increasingly important since the 1990's in response to infectious disease outbreaks. Using GIS/GPS technology location-based monitoring of vector habitats, surface areas of water, environmental terrain, and human activity can be mapped with disease incidence and prevalence allowing sources of disease outbreaks to be identified quickly and interventions to be focused. Although GIS methodologies have been used to save resources and reduce error during vector borne disease outbreaks there is still minimal measure of the burden/impact of dengue fever in Latin America. We hypothesize that GIS technology will be useful in Nicaragua to assess the burden of disease, guide the accurate delivery of resources to manage dengue outbreaks, and assess the efficacy of targeted interventions such as spraying for mosquitos or intensive educational efforts. In order to assess this hypothesis we plan to analyze aggregate population data from registries situated in the Nicaraguan Ministry of Health. Codified dengue cases before and after an intervention where GPS was used versus where GPS was not used will be reviewed in a retrospective fashion. The data will be used to study the effectiveness of GPS for identifying outbreaks and targeting interventions such as insecticide spraying to particular neighborhoods, administration of larvicides to particular household water containers, and educational efforts targeted to specific neighborhoods.

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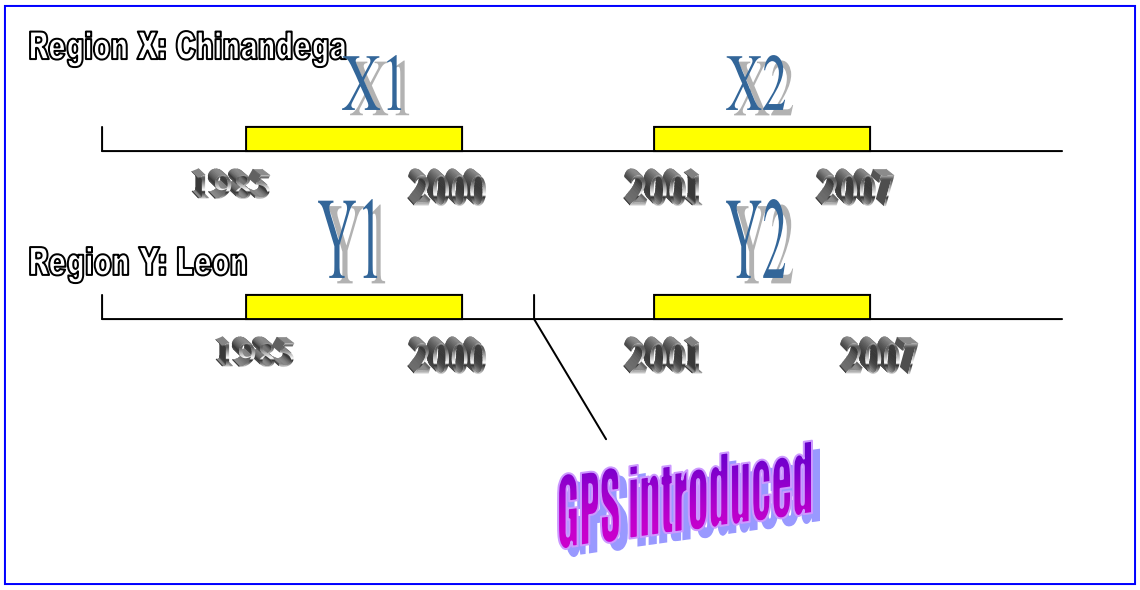
2. Study Design and Statistical Procedures

In order to determine the scope of dengue and utility GPS technology in outbreak management we will perform an analysis of aggregate data from the Ministry of Health pertaining to codified dengue cases from 1985 to 2007 in Leon and Chinandega. Exact dates and locations of GPS interventions will be verified on site at the Ministry of Health in Nicaragua however it is suggested that GPS interventions began around 2000 in Leon before they were introduced to Chinandega. We will compare the number of cases in Chinandega and Leon before and after GPS guided interventions.



Statistics: We will perform a chi-squared test on proportions from the two groups. The incidence of dengue has been approximately equal between the two cities prior to the introduction of GPS. Since during this time period there have been approximately 25,000 cases of dengue in Chinandega and Leon individually we will be able to detect to a one percent change in the proportion. We will use a significance of .05 and a power of 80%.

3. Study Procedures

1. Determine the **scope of Dengue**
    a. Pick two similar **regions** in Nicaragua such as Leon and Chinandega: Define these regions based on area, population density, rainfall, temperature, humidity, rate of incidence of dengue, sampling systems to diagnose dengue, neighborhood descriptions, rural/urban environment, zoning, proximity to standing water etc.
        i. Within each area per year describe the **demographics of the populations:**
            1. # of people
            2. age
            3. sex
        ii. Describe the **vector properties:**

1. mosquito density
2. mosquito survival percentages

b. Define a definitive **time frame** to analyze the data from these two regions in which GPS guided interventions were used in one area but not the other.
c. Calculate the **incidence** of dengue in these two areas per week.

For each Time period 1 or 2 at location X or Y describe the following parameters:

- **# of dengue cases *per week***
  - Define how diagnosis was made:
    - serologic diagnosis
    - clinical diagnosis with high fever, headache, nausea, vomiting, and severe muscle pains
  - Age of cases
  - Sex of cases
- Define the **morbidity** with
  - # hospitalized
  - The duration of the illness
  - # self limited
  - # affected by hemorrhagic fever: vascular shock, kidney damage, capillary rupture causing petechiae and scleral bleeding
  - # with end organ dysfunction due to vascular shock
    - Liver
    - CNS
    - Kidney
- Determine # of **mortalities**
  - # of mortalities due to dengue
  - # of mortalities due to hemorrhagic fever

2. For the **cost analysis**, we will also analyze parameters within X1/2 and Y1/2 such as:
   a. Administrative costs at Organizational level from the National Budget for Epidemiological disease control
      i. Salary of public health workers
      ii. Operation costs of the ministry and general direction funding
      iii. Stipends for workers meals and work-related travel
   b. Cost of preventative measures
      i. Cost of Abatement/insecticides
      ii. Operating cost of providing surveillance and fumigation like gas for the vehicles
      iii. Cost of vehicles needed for fumigation
      iv. Cost of maintenance of the vehicles
      v. Cost of replacement of the unusable vehicles
      vi. Cost of salaried workers to implement these measures
          1. including three meals per day and travel expenses
      vii. Cost of Propaganda and educational materials
   c. Cost of treatment

i. Cost at public/private outpatients centers
ii. Cost of public/private inpatient centers
    a. Determine average number of days of hospitalization
        2. Cost of a pediatric intensive care bed
        3. Cost of a neonatal intensive care bed
        4. Cost of general pediatric ward bed
        5. Cost of adult intensive care bed
        6. Cost of adult general ward bed
iii. Cost of medications used to treat Dengue
        1. Cost of lactate ringers
        2. Cost of acetaminophen

d. Cost to the national economy
    i. Loss of productivity per worker affected by dengue: can be calculated by stratifying number of patients in a certain age range/gender and average wage for age range.
e. Cost of GPS/GIS

3. Study Drugs or Devices: non-applicable
4. Study Questionnaires: non- applicable
5. Study Subjects: Codified dengue cases from the Ministry of Health from 1985 to 2007 in Leon and Chinandega.
6. Recruitment: non-applicable
7. Confidentiality of Study Data: Codified cases.
8. Potential Risks: none.
9. Alternatives: not applicable.

Exempt declaration: retrospective deidentified coded population based data review.