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EG3246 Spatial Science and Health

Examining Epidemic Patterns

2009 Edition

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Introduction

There are many examples of diseases where the chief co-factor influencing the epidemiological characteristics is *environment*. Whether the *physical environment* (weather, proximity to industrial zones, hazards etc) or the *human environment* (poverty, marginalised people, political, etc).

In such cases, we can analyse patterns of disease in both space and time. Time-dependent (or seasonal) cases of a disease are often linked to annual cycles of weather and climate. For example, malaria and bacterial meningitis are diseases strongly associated with weather conditions and the physical environment. Patterns may also exist in space reflecting both the migratory and dynamic motions of the human host and agent of transmission (vector). Some diseases may be air-borne, water-borne or vector-borne. Malaria is commonly referred to as a "tropical disease" although its geographic distribution is not exclusively constrained within the tropics of cancer and Capricorn.

Malaria is a "vector-borne" disease – so called because it is transmitted by an insect vector (the female mosquito of the genus Anopheles). Most world cases are to be found throughout the African continent with common mosquito species such as Anopheles gambaie being responsible. The actual cause of malaria is a parasite of the genus Plasmodium (such as the common species Plasmodium falciparum) which is transmitted from person to person by the mosquito. During bloodfeasting (being bitten!) the mosquito transfers immature parasites (sporozoites) into the human host's bloodstream. Once in the bloodstream the parasites will develop and begin to damage blood cells and key organs such as the liver and brain. Malaria is often referred to as a childhood disease because it primarily kills children below the age of six (who have yet to acquire a natural immunity). Throughout Africa, malaria is believed to be responsible for the deaths of about 3million people each year – mostly children.

Practical Objectives
During this practical you will use a variety of data sources to examine the geographical distribution of malaria in Africa.

You will examine existing malaria indicator maps created by the MARA organisation (details in your Reader document) and consider environmental factors such as rainfall, temperature, vegetation etc as co-factors affecting the patterns of malaria distribution.

During your investigations you will examine geo-referenced sources of malaria case statistics (distributed by MARA) and relevant scientific literature (journal articles) to help synthesise your own results and ideas into a scientific argument.

Data Sources
Some of the key data are provided for you in the **J:** (Gaia) drive EG3246 unit folder:

Environmental IDRISI data:
- Bailey Ecoregions of Africa
- Monthly and Mean Annual Rainfall Data for Africa (Hutchinson)
- Wilson and Henderson-sellers Land Cover Classes data for Africa
- FAO Soil Map for Africa

MARA IDRISI Data:
- Various MARA modelled and observed Malaria indicator maps for Africa

MARA Microsoft Excel data:
- Distribution of A. gambaie data (MARA)
- Distribution of Entomological Inoculation Rate[1] (EIR) data (MARA)

THE FOLLOWING TECHNIQUE IS JUST TO GET YOU STARTED BUT NOT EVERYTHING YOU NEED TO DO FOR YOUR ASSIGNMENT! YOU SHOULD EXPLORE THE FUNCTIONS OF IDRISI AND SELECT OTHER APPROPRIATE TECHNIQUES AS WELL

A powerful module present in IDRISI is called **PROFILE**. It allows data to be profiled (sampled) through space and time. You may begin by conducting a spatial analysis (over space) using **transect** lines.

Transect lines are lines that you can draw directly on the screen using the onscreen digitize function:

1) To sample values across a transect line, we must first create a transect line. This transect line will be used by IDRISI to generate a file or image depicting the Pixel values (representing the values of variables like rainfall or malaria prevalence) we want to analyse.

2) To draw our transect line, we must have our chosen image (e.g. **monthrisk3cat** from the MARA IDRISI image collection) currently displayed, with the outline of Africa visible (using **ADD LAYER** from **COMPOSER** and finding a map file from the J: drive – e.g. **Mali** from the

[1] EIR = Number of mosquito bites during night multiplied by proportion of those bites positive for presence of plasmodium sporozoites

Environmental Idrisi Data\Map Files folder). You will find it easier to use the **Zoom Window** feature from the toolbar to zoom in to Mali. Now click on the **On Screen Digitize button**, located near the centre of the Toolbar along the top. It looks like a crosshair. When asked for a name to give your transect line, enter something useful like **TRANS1**. Now click on the **LINE** option, and then click on **OK**. (**NOW READ PARTS 3 to 5 BEFORE PROCEEDING**)

3) You will notice that when you move the mouse cursor over the image, it changes to a crosshair. Place the crosshair over the country boundary in the Northeast of Mali. Just before you click on the mouse button, make a note of the X and Y geographic coordinates shown at the bottom of the screen:

X value	Y value

4) Now click with the LH mouse button and move the crosshair cursor to a point along the Southwest of Mali. Click again with the LH mouse button, and immediately make a note of the new X and Y coordinates:

X value	Y value

5) You should now see a straight line extending from the Northeast to Southwest of Mali. To finish the onscreen digitizing, click anywhere on the image with the RIGHT HAND mouse button (now see FIGURE 1). The crosshair cursor should now change back to an arrowhead. To finish creating your transect line, close down the image window by clicking on the X in the top right hand corner of the Image window. IDRISI will ask if you want to save the vector file. Select **YES**.

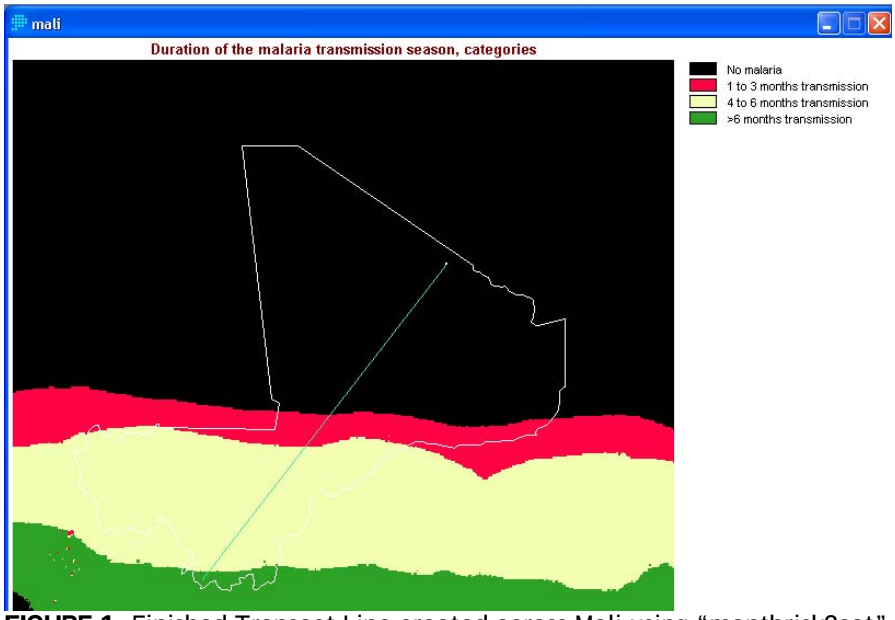

FIGURE 1: Finished Transect Line created across Mali using "monthrisk3cat" Image

6) By this point, you have created a transect line running from across Mali from Northeast to Southwest. Our next task is to sample the Pixel values along this line.

7) From the menubar, select **ANALYSIS**, then **CHANGE/TIME SERIES**, and then **PROFILE**. We want to sample the duration of malaria transmission in space (along the transect line), so

make sure the "Over Space" option is selected. In the text box labelled "Vector file containing profile line", enter the name of your transect line (called **TRANS1** perhaps). In the second textbox labelled "Name of the image to be profiled" enter **monthrisk3cat**. Click on the **"Save as values file"** option giving the "Values file name" as **MALIMONTHRISK3CAT**, and then click on **OK**. You will see a graph displayed on the screen (now see FIGURE 2). The X axis represents the vertical distance along your transect line from North to South, whilst the Y axis values represents the Pixel values sampled by IDRISI along that line. Remember, the Pixel values actually represent the duration of malaria transmission along the transect in Mali:

0 = No malaria
1 = 1 to 3 months transmission
2 = 4 to 6 months transmission and
3 = >6 months transmission

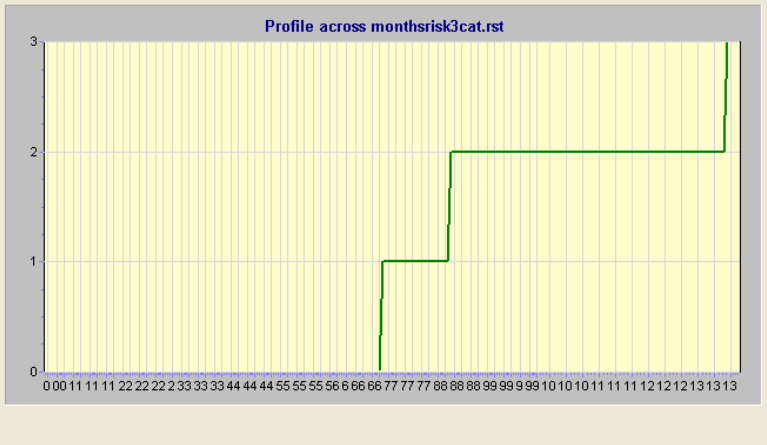

FIGURE 2: Transect results for Mali – showing increasing duration of transmission from NE to SW

DO NOT use the graphs (like Fig. 2 above) in your assignment report. Use the values file PROFILE created in step 7 (above) which can be imported into Excel as a text file. Create your own annotated graphs – or undertake appropriate statistical tests on the data. Because you recorded the start and end coordinates of your transect line in steps 3 & 4 above you can label the Latitude or Longitude axes in your graphs by dividing the distance between the start/end points by the number of pixels along the transect

Additional Methods

Now you have seen how IDRISI allows you to sample values of relevant data across space. You may begin to explore the data and link specific cases from the MARA Excel files for points around Africa. Try and discover to what extent the physical environment is responsible for the patterns of malaria across the continent.

You have been provided with quite a bit of varied disease (MARA) data and additional environmental information. Be as imaginative and logical with the data and tols you have as possible.

Some Literature & Organisational Resources
In addition to the documentation provided with the data in the relevant J: drive folders (and using GOOGLE searches on the Internet) you can link your practical writing and analysis with relevant peer-reviewed scientific journal articles. Some examples are provided for you (accessed via Sciencedirect):

Atul A. Khasnis and Mary D. Nettleman (2005). **Global Warming and Infectious Disease.** *Archives of Medical Research, Volume 36, Issue 6, Pages 689-696*

Hamza A. Babiker, Gwiria Satti, Heather Ferguson, Riad Bayoumi and David Walliker **(2005). Drug resistant** *Plasmodium falciparum* **in an area of seasonal transmission .** *Acta Tropica, Volume 94, Issue 3, Pages 260-268*

Simon I Hay, Carlos A Guerra, Andrew J Tatem, Abdisalan M Noor and Robert W Snow (2004). **The global distribution and population at risk of malaria: past, present, and future .** *The Lancet Infectious Diseases, Volume 4, Issue 6, Pages 327-336*

A. J. Graham, P. M. Atkinson and F. M. Danson **(2004). Spatial analysis for epidemiology.** *Acta Tropica, Volume 91, Issue 3, Pages 219-225*

The Liverpool School of Tropical Medicine:
http://www.liv.ac.uk/lstm/

The London School of Hygiene & Tropical Medicine:
http://www.lshtm.ac.uk/

MARA/ARMA (mapping malaria risk in Africa):
http://www.mara.org.za/

The WHO regional office for Africa is http://www.afro.who.int/

The WHO Roll Back Malaria (RBM) initiative http://www.emro.who.int/rbm/