ISSN: 2456-2912
VET 2020; 5(4): 18-21

www.veterinarypaper.com
Received: 10-05-2020
Accepted: 11-06-2020

Kamal Hashan Bulbul
Division of Veterinary Parasitology, FVSc &AH, SKUAST-K, Shuhama, Srinagar, J&K, India

D Choudhury
Department of Veterinary Parasitology Lakhimpur College of Veterinary Science, Assam Agricultural University, North-Lakhimpur, Joyhing, Assam, India

Rabeya Begam
Department of Veterinary Parasitology College of Veterinary Science, AAU, Khanapara, Assam, India

K Roy
Department of Veterinary Parasitology College of Veterinary Science, AAU, Khanapara, Assam, India

S Bora
Department of Veterinary Parasitology College of Veterinary Science, AAU, Khanapara, Assam, India

Corresponding Author:
Kamal Hashan Bulbul
Division of Veterinary Parasitology, FVSc &AH, SKUAST-K, Shuhama, Srinagar, J&K, India

The prospective of geographic information systems and satellite remote sensing in schistosomosis with especial reference to Assam

KH Bulbul, D Choudhury, Rabeya Begam, K Roy and S Bora

Abstract
Schistosomosis, the snail-borne parasitic disease due to *Schistosoma spindale, S. indicum, S. nasale* and *S. incognitum* causes economic losses to farming community in the endemic areas. Therefore, proper strategic control measures have to be formulated in perspective of a particular region of the country to up-lift the rural economy. The applications of geographic information system (GIS) along with remote sensing (RS) help in acquiring epidemiological information and relate it to factors known to influence the distributions of snail-borne schistosomosis to map out the disease surveillance in tropical and sub-tropical countries. The prevalence of *Schistosoma* spp. in different ecological zone can be observed by the using of Advanced Very High Resolution Radiometer (AVHRR) pathfinder satellite sensor data because of the adaptation of the intermediate host snails to semi-permanent water bodies in the endemic areas of schistosomosis. Understanding the environmental limits of infection can also be aided the targeting of national control strategies for some parasitic diseases of livestock. The water logging habitats for snail intermediate hosts both in Brahmaputra and Borak valley of Assam play the significant role in dissemination of schistosomosis in livestock. The early prediction of the disease is very much important to formulate the strategic control of the disease. Therefore, the development of predictive models of spatial distribution of schistosomosis based on GIS and RS data helps in controlling schistosomosis.

Keywords: Schistosomosis, GIS, RS, Assam

Introduction
Schistosomosis, the most important snail borne parasitic disease in domestic animals, man and birds is mainly recognized as three form namely urinary, hepato-intestinal and nasal schistosomosis in India [1, 2, 3]. Many species of schistosomes were reported from India in domesticated animals from time to time [3]. They are *Schistosoma nasale*, *S. indicum*, *S. spindale*, *S. incognitum*, *Ornithobilharzia turkestenicum*, *O. datti* and *Bivitellobilharzia nairi* [4]. This disease is of great concern for the morbidity rather than mortality producing deteriorates health and loss of production whose distribution is particularly sensitive to environmental change, most clearly environmental change of human origin. There are several events looming which promise major environmental changes: the construction of the water project *viz.* dam, irrigation channel and the increasing probability of flood due to global warming.
The presence of susceptible snail hosts is essentially crucial requirement for establishment of snail-borne schistosomosis in man, animals and birds. *Indoplanorbis exustus*, a freshwater snail is the only natural intermediate host for *Schistosoma indicum*, *S. nasale* and *S. spindale* on the Indian sub-continent [2, 5] and widely prevalent in this part of the country. The snail (*I. exustus*) populations in relation to aquatic vegetations in different seasons play a pivotal role in dissemination of *S. indicum*, *S. spindale* and *S. nasale*. On the other hand *Lymnaea luteola* act as intermediate hosts for *S. incognitum*, the causative agent of hepato-intestinal schistosomosis in goats [2]. A distribution map of the snails based on ground information as well as multi-season satellite remote sensing data and GIS data give the sentry information of disease surveillance of schistosomosis.

Important of geographic information system and satellite remote sensing
GIS and remote sensing can play a significant role in the rapid planning of helminths control

programmes including schistosome where little information on disease burden is available. Remote sensing prediction models can indicate patterns of geo-helminthes infection but can only identify potential areas of high risk for *S. haematobium* group, *S. japonicum group*, *S. mansoni* and *S. indicum* group. The application of GIS and RS can be used to guide a justifiable rapid epidemiological survey of different *Schistosoma* spp. as a basis for developing a national control programme in endemic areas. It also helps in prediction of the environmental factors of different *Schistosoma* group in our country. Such predictions are supported by experimental data in the field condition. In the areas, where rice production is more common and especially in stagnant ponds and irrigation ditches capable of supporting populations of snails (*I. exustus, Lymnaea luteola, Bulinus globosus* and *B. truncatus* throughout the year. These factors illustrate the importance of considering the occurrence of man-made features and other small-scale environmental factors that are not readily measurable in large scale RS data.

What is Geographic Information System (GIS)?

The GIS technology has evolved from geography and geo-type discipline which consisting of hardware, software, data, people, organisation and institutional arrangement for collecting, storing, analyzing and displaying information about the areas of earth. It is a powerful set of tools collecting, retrieving at will, transforming and displaying spatial data from real world. Overall a GIS is a platform consisting of hardware, software, data, people and method (set of value added tools). GIS methods includes applicable set of value added tools for capturing, transforming, managing, analyzing, and presenting information that are geographically referenced. A GIS is a computerized system that combines spatial and descriptive data for mapping and analysis [6]. One of the main strengths of a GIS is its ability to integrate different types of spatial data. For example, a GIS can be used to map available epidemiological information and relate it to factors known to influence the distribution of infectious diseases, such as climate and other environmental factors. The ability to acquire relevant climatic information, particularly in the tropics and subtropics, where there is an inadequate infrastructure for the collection of meteorological data, has been enhanced by remote sensing (RS) techniques that can provide proxy environmental information derived from satellite sensors [7, 8, 9]. RS environmental variables have been used to explain the distribution of various infectious diseases, with direct application to disease control programmes [8]. Understanding the environmental limits of infection can aid the targeting of national control strategies, as has been demonstrated for onchocerciasis [10] and filariasis [11].

Remote sensing satellites

A satellite with remote sensors to observe the earth is called remote-sensing satellite, or earth observation satellite which is characterized by their altitude, orbit, and sensor. The TIROS, NOAA, GMS, LANDSAT, SPOT, MOS, JERS, ADEOS, ESR, RADARSAT, IRS, etc. are the several remote sensing satellites in operation. The NOAA satellite series, the third generation meteorological satellites operated by the NOAA, USA, with Advanced Very High Resolution Radiometer (AVHRR) sensors, with an altitude of 850 Km in a polar orbit, is mainly designed for meteorological observation but is also successfully used for vegetation monitoring. India has the indigenous series of satellites called Indian Remote Sensing satellites (IRS- series). Since the launch of the first satellite IRS 1A in 1987, India has now a number of satellites providing data in multispectral bands with different spatial resolution. IRS P6/ RESOURCESAT 1 are the current generation satellite that provides multi-spectral images in spatial resolution of 5.8 m (LISS IV), 23.5 m (LISS III) and 56 m (AWiFS). Indian Remote Sensing data has been successfully used in various fields of natural resources. Currently, there are many land resource remote sensing satellites that have sensors operating in the green, red, near infrared, and short wave Infrared regions of the electromagnetic spectrum giving a definitive spectral signature of various targets due to difference in radiation absorption and reflectance of targets. These sensors are of common use for land cover studies, including vegetation and wetland. Converted to image, in a typical false colour composite created using NIR, red and green bands assigned as red, green, and blue colour, the feature become very distinct. As a colour composite within an infrared band is no longer natural colour, it is called false colour composite (FCC). In FCC, the vegetation thus appears invariably red due to high reflection in near infrared from green leaves floated in the water logged areas.

In contrast, the use of RS environmental observations by satellite sensors allows quantitative measurements of key climatic variables at regular intervals on the regional scale. Using AVHRR pathfinder satellite sensor data, we can observed the prevalence of *Schistosoma* spp. in different ecological zone because of the adaptation of the intermediate host snails to semi-permanent water bodies in the endemic areas of Schistosomosis. Using the same AVHRR Pathfinder satellite sensor data, it is possible to characterize these areas of potential schistosome transmission many countries. The correlations between observed disease patterns and RS environmental variables can also be used to extrapolate risk estimates to areas for which no data are available. It is unclear, however, whether predictions developed for one country are useful in describing infection patterns in another, since the environmental factors that influence disease transmission are unlikely to be uniform over large geographical areas [12].

Methods

1. Remotely sensed environmental data

The deprived spatial resolution of meteorological data can be taken by using remotely sensed environmental data derived from the AVHRR sensor on the US National Oceanic and Atmospheric Administration's (NOAA) polar-orbiting meteorological satellites or IRS 1B LISS 2 A2. These data will be used to calculate mean annual summaries of surface brightness temperatures (expressed as land surface temperature) and photosynthetic activity estimates, expressed as the normalized difference vegetation index. This can be involved standard procedures of data processing and quality control [7]. Minimum, mean, and maximum values of remotely sensed data will be used. The precision of RS methods for providing estimates of temperature can be investigated by comparing estimates of land surface temperature with meteorological ground measurements. The correlation between land surface temperature and ground observations is sufficiently strong for practical applications in epidemiological mapping of schistosomosis.

2. Sampling design

Stratified sampling by ecological zone overlaid with population data can be used to select study areas. A map of ecological zones in Schistosomosis endemic areas will be derived from the RS environmental data described above. These data, in combination with a digital elevation model and interpolated rainfall surfaces will be used to generate ecological zones by means of the unsupervised classification procedures of Earth Resources Data Analysis System (ERDAS) Imagine 8.4™ software or *ArcGIS/ ArcInfo* software. ERDAS implements the iterative self-organizing data analysis technique, which uses Euclidean distance as a similarity measure to cluster data in discrete classes, independently of their geographical location [13].

3. Field investigations

Diagnosis of both hepato-intestinal and nasal Schistosomosis can be performed by conventional Kato-Katz method; serological and molecular technique in animals, men and birds. The geographical location in terms of latitudes and longitude of study areas can be identified in the field by means of a non-differential global positioning system (GPS) device (Magellan NAVDLX). Assam Remote Sensing Application Center (ARAC) is actively working on various fields in remotely sensed data acquisition.

Substantiation of RS prediction models for Assam

Multivariate logistic regression models can be developed to identify the main predictors of schistosomes prevalence in animals, men and birds. The maximum land surface temperature, rainfall and normalized difference vegetation index are the main environmental variables. A 5-10 Km buffer zone around the endemic areas will be created to take the values of the pixels in each buffer zone [5]. Statistical correlations between epidemiological data and RS environmental data will be interpreted.

Scope of schistosomosis control through application of remote sensing and GIS

A GIS-based buffering zone boundary map of the neighbouring areas with proximity to snail breeding sites of irrigation canals, dam, paddy fields, black cotton soils and the areas under wetland agricultural practices are to be identify as the most suitable environment for snail populations and thus, the areas are vulnerable at risk of schistosomosis transmission [14]. The meteorological satellite remote sensing derived temperature difference of LST and SST data is a guide for mapping of appropriateness of the environment for local snail hosts and Schistosomosis transmission risk at the local level. The climate and environmental changes and their impact on the propagation of vector snails of different species of genus *Schistosoma* and the risk of transmission are tackled with aid of remote sensing and GIS. However, the applicability of the RS and GIS advanced technology is inaccessible in Assam where the problems of schistosomosis transmission risk are very high both in animals. These can be conquer, if the World Health Organization (WHO) and funding agency of other developed nations come forward for funding the research projects of RS and GIS technology and its applications to the schistosomosis control. If succeeded, the RS and GIS-based models may perhaps provide useful information to a disease prediction model for disease control programme and also provide a baseline to the managers for the disease control, particularly in Assam.

The development of prognostic models of the spatial distribution of schistosomosis is hindered by the existence of different regional species of the snail that serve as intermediate hosts for the disease in Assam. The habitats associated with these different species vary considerably, with water logging habitats in both Brahmaputra and Borak valley of Assam. The global warming that threatens to increase snail habitat, as well as limited public health resources, requires the ability to accurately map and prioritize areas at risk for schistosomosis. Moreover, deforestation reduces acidic leaf litters and increases algal growth in ponds and streams creating conditions suitable for snails that serve as intermediate host for schistosome.

The favourable environmental conditions must exist for the snail vector to establish itself and complete the lifecycle of the schistosome parasite to persist the Schistosomosis. The IRS/ Landsat ™ can be used to identify habitats suitable for snails, and distinguish these habitats from non-habitats that do not support snails in the flooded areas or draught areas. It may be hypothesized that at a macroscopic level visible from TM imagery there may exist environmental factors useful in the determination of habitats suitable for snails. These environmental factors may include vegetation, crop type, soil type, moisture, and temperature. All of these factors vary from region to region and may affect the suitability of an area to support snails. However, it is also important to understand that these ecological differences might be quite slight and, in some cases, not observable using remote sensing, such as the use of molluscicides.

Conclusion

The GIS and RS can be utilized to predict the schistosomosis for formulating the strategic control measures in endemic areas like Assam, India to reduce the economic losses of the livestock keeper.

References

1. Bulbul KH. Studies on *Indoplanorbis exustus* and its associated schistosomes. Ph.D. Thesis, Assam Agricultural University, 2016, 152-164.
2. Bulbul KH, Das M, Islam S, Sarmah PC, Tamuly S, Borah P *et al*. Prevalence of nasal schistosomosis in cattle of Kamrup district of Assam, India. Veterinary Practitioner. 2017; 18(2):213-215.
3. Bulbul KH, Das M, Islam S, Tamuly S, Borah P *et al*. Molecular epidemiology of visceral schistosomosis caused by Schistosoma spindale infection in cattle of Assam, India, Biological Rhythm Research. DOI: 10.1080/09291016.2019.1616902.
4. Kumar V, de Burbure G. Schistosomes of Animals and man in Asia. Helmthological Abstract, (Series A). 1986; 55(12):469-480.
5. Ravindran R, Lakshmanan B, Ravishankar C, Subramanian H. Visceral schistosomiasis among domestic ruminants slaughtered in Wayanad, South India. South-East Asian Journal of Tropical Medicine and Public Health. 2007; 38:1008-1010.
6. Burrough PA, McDonnell RA. Principles of geographical information systems. Oxford: Oxford University Press, 1998, 16-34.
7. Hay SI, Randolph S, Rogers DJ. Remote sensing and geographical information systems in epidemiology. London: Academic Press, 2000, 123-156.
8. Hay SI. An overview of remote sensing and geodesy for epidemiology and public health applications. Advances in Parasitology. 2000; 47:2-27.
9. Goetz SJ, Prince SD, Small J. Advances in satellite remote sensing of environmental variables for

epidemiological applications. Advances in Parasitology. 2000; 47:289-307.
10. Ngoumou P, Walsh JF, Mace JM. A rapid mapping technique for the prevalence and distribution of onchocerciasis: a Cameroon case study. Annals of Tropical Medicine and Parasitology. 1994; 88:463-74.
11. Lindsay SW, Thomas CJ. Mapping and estimating the population at risk from lymphatic filariasis in Africa. Trans-actions of the Royal Society of Tropical Medicine and Hygiene. 2000; 94:37-44.
12. Brooker S, Hay SI, Bundy DA. Tools from ecology: useful for evaluating infection risk models. Trends in Parasitology. 2002; 18:70-74.
13. Jensen JR. Introductory digital image processing. A remote sensing perspective, Saddle River, NJ: Prentice-Hall, 1996, 197-256.
14. Leonardo LR, Rivera PT, Crisostomo BA, Sarol JN, Bantayan NC, Tiu WU. A study of the environmental determinants of malaria and schistosomiasis in the Philippines using remote sensing and geographic information systems. Parassitologia. 2005; 47(1):105-14.