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GEOGRAPHIC INFORMATION TECHNOLOGY APPLICATIONS FOR URBAN INTEGRATED PEST MANAGEMENT

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Abstract Madrid City Council has always used maps for this purpose and in the last decade has taken a further step incorporating Geographical Information Technologies (GIS). As a result urban pest control has improved notably and integrated pest management principals have been straightforwardly accomplished. This technological development has required and is still requiring budget and staff effort, however it allows a very powerful data management and analyse in a unique way. Currently, city pest management is highly influenced by GIS analyse, allowing better decision making and resource optimization. This manuscript provides general information about the implementation process, results obtained and relevant conclusions.
Key words GIS, vector surveillance.

INTRODUCTION

Pest prevention and control operations require the location of pest problems (García-Howlett and Cámara, 2009). Traditionally this requisite has implicated the use of plans or maps depending on the scale of the problem. Additionally, specialists that work on pest control need to identify evaluate and manage all environmental factors that determine and interact with pest problems. To accomplish IPM strategies (Brenner et al., 2003; Lacey, 2006) it is fundamental to identify and acquire the biological, social, economical, geographical and environmental data that establish the different pest situations. Understanding the environmental determinants of vector-borne disease transmission is critical to predict and prevent pest/vector risks.

GIS are tools that permit a technical and scientific based collection, processing and management of data (Bosque-Sendra, 1997). Global Positioning Systems (GPS) and GIS are now essential vector-control tools (Bonnefoy et al., 2008). These technologies allow researchers and organizations to study and publish vector risks based on a cartographic approach (Lawson et al., 1999; Albert et al., 2000; Durr and Gatrell, 2004).

Health Madrid, as the municipal health administration of the City Council of Madrid manages pest prevention and control operations. For the Vector Control Unit (UTCV) GIS is not only a complex software solution for individual health problems, but a corporative and widespread strategy for the global processing of information. All municipal pest/vector programs and work interventions are planned and developed with the help of GIS (Cámara and Tamayo, 2008; Cámara et al., 2012; Tamayo, 2013).

MATERIAL AND METHODS

Pest and vector prevention GIS applications principally arise from experiences focused on singular vector problems (Traweger and Slotta-Bachmayr, 2005) and applied to large areas (Estrada-Peña, 1998). Translation of GIS applications to a more complex urban range and to several animal species implicates the need of a comprehensive approach.

In 2005, collaborating with the Computer Services of the City Council (IAM), Health Madrid (UTCV) started developing a global GIS scaled project based on two general approaches. Firstly designing and developing a "user friendly" corporative software, accessible for pest related municipal professionals that also allows to extract data; secondly a more powerful desktop GIS software solution, where internal and external information may also be incorporated and analysed. In this context, UTCV had to reorganize in order to adapt to this new technology which involved internal operation redesigning, improving data management and staff training.

The corporative GIS is the most challenging goal, because of its cost, complexity and project schedule. The decision of using previous GIS projects, derived from other municipal department (urban planning), proved to be a good option in order to reduce cost and promote collaboration. Desktop GIS solutions are easy to incorporate in any organization and have a lower cost but require higher qualified users. Although they can be a temporal solution for urban pest control units, UTCV considers that the combination of both corporative and desktop solutions is the best option (Cámara et al., 2012).

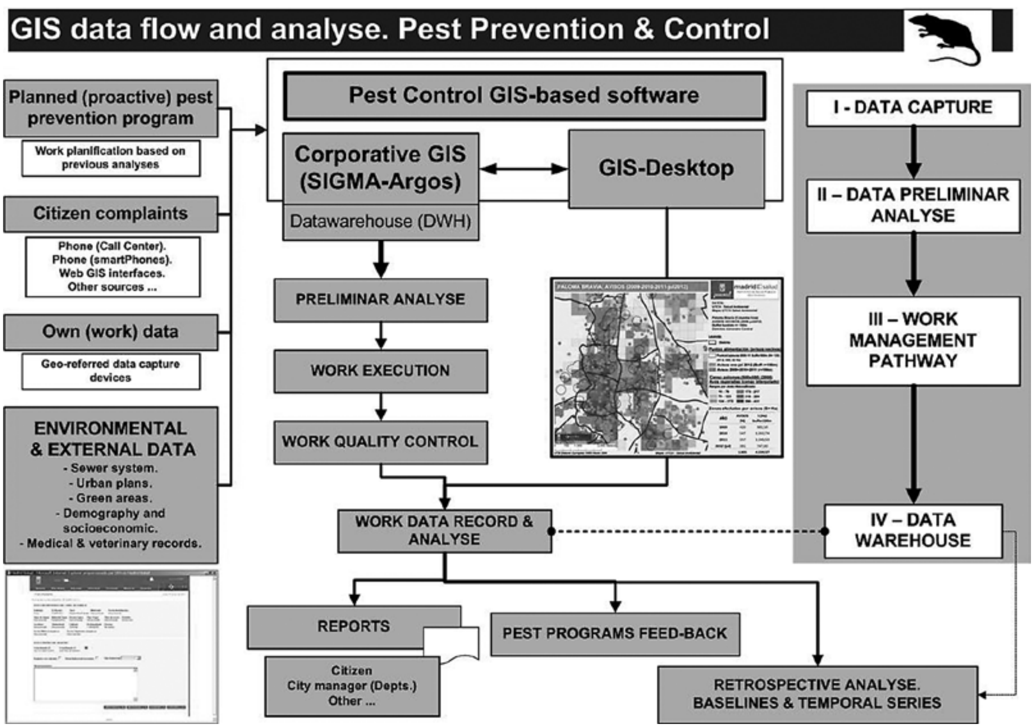

Figure 1. UTCV GIS process flow diagram.

Any municipal pest computer program usually is based on a general process in which citizen complaints, management operations, data analysis and reports are included. All of them are deeply affected by GIS capabilities. The most critical element is the precise geographical coordinates of events, an automatic process in UTCV corporative GIS as you can see in Figure 1. Next step implicates preliminary GIS analysis and event characterization (environmental factors, background reports), allowing to fulfil an accurate diagnoses (Tamayo, 2013). Afterwards the control measures are determined and carried out, where GIS helps to manage logistic and task assignments. Corporative software is designed to permit additional work data capture in order to improve future analysis. Last step includes report generation for both external and internal use. Map use associated to external reports is attractive and useful, however results essential for internal technical analysis, see Figure 2.

Accurate pest/vector risk management implicates extra performance (Estrada-Peña, 1998; Elliot et al., 2000; Moore and Frier, 2004; Tamayo, 2013). Prevention strategies implementation, continuous evaluation and vector monitoring are essential parts of IPM programs (Bonnefoy et al., 2008). All of them are improved by GIS and have proved so in Madrid (Cámara et al., 2012). GIS can manage huge spatial database and can carry out complex spatial data analysis and modelling (Smith et al., 2007) allowing mathematically based decisions for pest control and prevention operations.

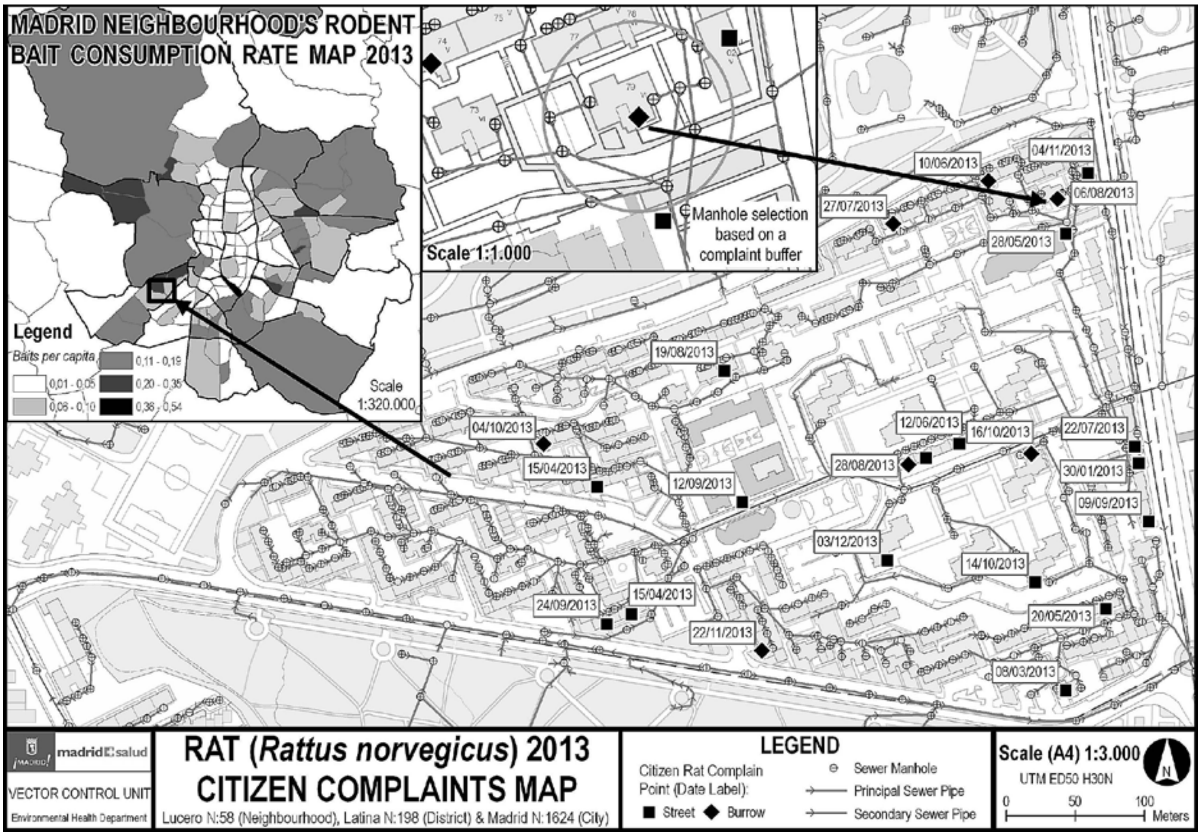

Figure 2. UTCV Example Map, Madrid neighbourhood rat (Rattus norvegicus) events.

Unexpected and extraordinary events, such as human and animal vector disease outbreaks (spatial epidemiology), animal abnormal mortalities, invasive animal management, natural or man borne catastrophes or hazards, are scenarios where GIS is an insuperable tool (Bosque-Sendra, 1997; Kitron, 1998; Elliot et al., 2000; Robinson et al., 2002; Moore and Freier, 2004; Durr and Gatrell, 2004).

RESULTS AND DISCUSSIONS

Almost ten years after GIS was introduced, this technology is globally implanted in all UTCV programs and activities as described in material and methods. Citizens can now notify pest related events directly in web maps linked to corporative software; which automatically realizes preliminary spatial analysis. Routine work planning and procedures are optimized by GIS analysis. Reports usually include thematic cartography so that citizen and city managers can access to map based information.

Spatial and temporal series of data are systematically checked, processed (Tamayo, 2013) and studied. Successive year programs are then influenced and replaned by previous data GIS analysis. State of art has allowed that in Madrid City Council spatial data sheets (GIS data layers) can be managed and provided by different municipal departments and also from other non municipal sources, in many occasions the information flow is bidirectional. Accessible data includes environmental and socioeconomic inputs, decisive to perform better descriptive and spatial health statistics (Gerin, 2003). As well, GIS tools have been systematically incorporated to pest monitoring, vector surveillance and animal disease outbreak, increasing the UTCV biological knowledge.

In a simplified approach, UTCV GIS assembles pest events (mostly citizen and public building complaints), environmental-socioeconomic factors and pest-vector monitoring results in a geodatabase and uses this data to carry out statistically based definition of pest threshold, relationship between pest and other variables, pest prediction models and program evaluations.

CONCLUSIONS

Pest control activities need to use spatial information (Bonnefoy et al., 2008). GIS technology incorporates a new perspective, allowing spatial data to perform a much more important function due to the quickness in fulfilling complex geographical analysis (Smith et al., 2007) and processes (Cauvin et al., 2007). This means better knowledge, efficiency and performance executing our role in local public health.

GIS has proved to be a helpful tool to succeed IPM strategies, thus pest prevention and vector-risk management can be substantially improved by its use. Urban environment are very complex scenarios where the access to spatial data and environmental information is critical (Gerin, 2003; Kanevsky, 2008). Systematic GIS use strengthen data analyze, internal evaluation practises and provide pathways to share information. GIS can be introduced in local pest control management in a different ways; under UTCV's point of view, a combination of a corporative and desktop solution has provided the best results.

Experience in Madrid has allowed detecting GIS intrinsical and operative problems, such as: poor data, analisis uncertainties, inaccurate map edition. All this can conclude in erroneous decision making, especially dangerous because maps are easily visualized and trustworthy.

Incorporating TIG to municipal pest management is a complex process with pre-established landmarks. UTCV has achieved access to technology, capable human resources and automatic georeferenced information, all of them defining a first landmark. The next landmark is the capacity to correlate spatial information, probably the most useful advantage of pest GIS, recently achieved by UTCV. Next phase opens technical opportunities concerning advanced geostatistics and remote sensing. In Madrid, GIS have improved municipal pest management based on better decision making and resource optimization.

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