EFITA WCCA CIGR
2013 Conference
June 23-27, 2013
TORINO, ITALY
Sustainable Agriculture through ICT innovation

Telemetry Data Collection and Visualization – Wild Animals´ Spatial Activities in the Czech Republic

Michal Stočes, Pavel Šimek, Jiří Vaněk, Jan Jarolímek, Jan Masner

All: Department of Information Technology , Czech University of Life Sciences Prague, Czech Republic, e-mail: {stoces, simek, vanek, jarolimek, masner} @pef.czu.cz

ABSTRACT

In our papers we discuss the issues of collection, processing and visualization of positional data. Gained knowledge and principles have been used for example in game's spatial activity evaluation in the Doupovske Mountains and the Sumava National Park in the Czech Republic. The database for analyses and processing have been formed by large data set obtained by cooperation with the Military Forests and Estates of the Czech Republic, the Sumava National Park and the Faculty of Forestry and Wood Sciences at the Czech University of Life Sciences in Prague.
Analytical and software solution have been developed by the Department of Information Technologies Faculty of Economics and Management at the Czech University of Life Sciences in Prague and is also being administered, managed and run by this IT department.

Keywords: Telemetry data, GPS, GSM, wild animals, Czech republic

1. INTRODUCTION

Owing to development of up-to-date ICT technologies it is technically relatively easy and not too expensive to obtain positional data and to transfer it online to be processed. There is a possibility to utilize the positional data in many industries, from security technologies, through logistic systems to agriculture and environmental protection. Certainly, this data is utilized also for research purposes.
The positional data is mainly gained via radio based GNSS (*Global Navigation Satellite System*). Nowadays, there are two available functional systems; GPS (*Global Positioning System*) created and managed by the U.S. Department of Defence and GLONASS (*Globalnaya navigatsionnaya sputnikovaya sistema*) operated by the Russian Aerospace Defence Forces. It is possible to gain the data through many mobile devices equipped with chips able to process satellite data (*animal colars, smart phones* ...). (Lechner, 2000) When the data is measured, it is saved into the memory of the device and then batched to be processed. It is possible to gain the data from the devices via wire or wireless technologies (*GSM, UHF, VHF or satellite communication*).

M.Stočes, P.Šimek, J.Vaněk, J.Jarolímek, J.Masner. "Telemetry data collection and visualization – wild animals´ spatial activities in the Czech Republic". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.
The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the Internation Commission of Agricultural and Biosystems Engineering (CIGR) and of the EFITA association, and its printing and distribution does not constitute an endorsement of views which may be expressed. Technical presentations are not subject to the formal peer review process by CIGR editorial committees; therefore, they are not to be presented as refereed publications.

2. MATERIAL AND METHODS USED

There is a variety of ways for the positional data to be collected, transferred and processed. Online collection, batch data transmission according to the chosen technology and time period followed by the validation of the data which is been archived including the possibility of further processing and display (e.g. map outputs) appears to be the optimum. On the basis of analysis of needs, principles and knowledge for online collection, validation, archiving and displaying of the positional data were obtained. (Stillwell, 2004)
Gained knowledge and principles have been used for example in game's spatial activity evaluation in the Doupovske Mountains and the Sumava National Park in the Czech Republic. The database for analyses and processing have been formed by large data set obtained by cooperation with the Military Forests and Estates of the Czech Republic, the Sumava National Park and the Faculty of Forestry and Wood Sciences at the Czech University of Life Sciences in Prague. The main objective of presented solution is continuous visualization of obtained spatial data - monitoring of wild animals. (Jarolímek, 2012) The whole solution is based on a web application where the data stored in the database of the validated positional data (data archive) is processed and the outputs are published to users. The software solution of the web application was released in the standard environment PHP 5 (*Hypertext preprocessor*) programming language with use of Nette framework version 2 libraries (Nette, 2013). The data is gained from the database server through the dibi database layer. (Dibi, 2013)
Google Maps developed by Google Inc is used to view the animals monitored. Communication with Google Maps is realised via Google Maps JavaScript API V3 (*Application Programming Interface*). Display of information about detected animals is created by the client-side of JavaScript with use of Query framework (Thanopoulos, 2012). The application is optimized for the most widely-used web viewers, i.e. viewers running on different operating systems and devices; desktops, notebooks as well as mobile devices like tablets or smartphones. Web server Apache, version 2 guarantees running of the application.

3. RESULT AND DISCUSSION

3.1 Wildlife telemetry

Marked animals are tracked by the Global Positioning System (*GPS*) in the form of a collar which records animal´s location with accuracy of within few meters. A GPS receiver records animal´s location, time and date at programmed intervals (i.e. usually 1hour-intervals). The collar also contains an activity sensor which records animal´s activity (whether it is feeding, resting, or moving). (Owen-Smith, 2012) Moreover, the activity sensor records the temperature and measurement accuracy. Newer collars are equipped with GSM modules containing telephone SIM cards, which enable data transport into user´s computer. (Figure 1) In general, validation and store of the data in the database system for post-processing or displaying is an advantage. (Fan, 2004)

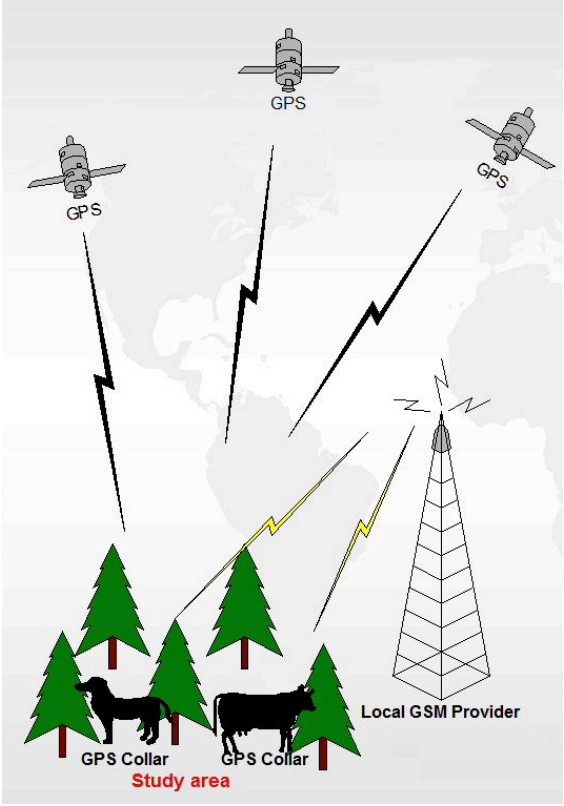

Figure 1. Schematic GSM communication (Vectronic Aerospace, 2013)

3.2 Data processing

Information about wild animals´ movements have been gained from GPS (*Global Positioning System*) collars equipped with a GSM module (*Groupe Spécial Mobile*). Acquired data have been validated and then stored in a database system. The data collected through the ground station is validated and then stored in the database system. (Figure 2) This process is realized by the software, specially developed for this purpose - Ground Station Harvester (*GSH 1.0*). (GSH, 2012)

The first game tracking and the data collection were realized in 2009 on Sika deer. Up to now (*15.5.2013*), the three game species - European deer, Sika deer and Wild bear – have been already monitored. The database contains of 56672 records of the position of 29 animals. (Table 1) The number of animals has been expanding.

Table 1. Quantity of the positional data

Game species	Number of monitored pieces	Number of positional data	First observation	Technology of collection
European deer	15	8678	28. 1. 2013	GSM
Sika deer	8	41305	31. 8. 2009	GSM/UHF/VHF
Wild bear	6	6689	16. 1. 2013	GSM

Games' positional data is recorded several times a day and then batched via GSM or UHF / VHF. (Figure 1) Also other information obtained through other sensors is recorded; it is primarily Activity sensor Temperature sensor. (Krop-Benesch, 2011)

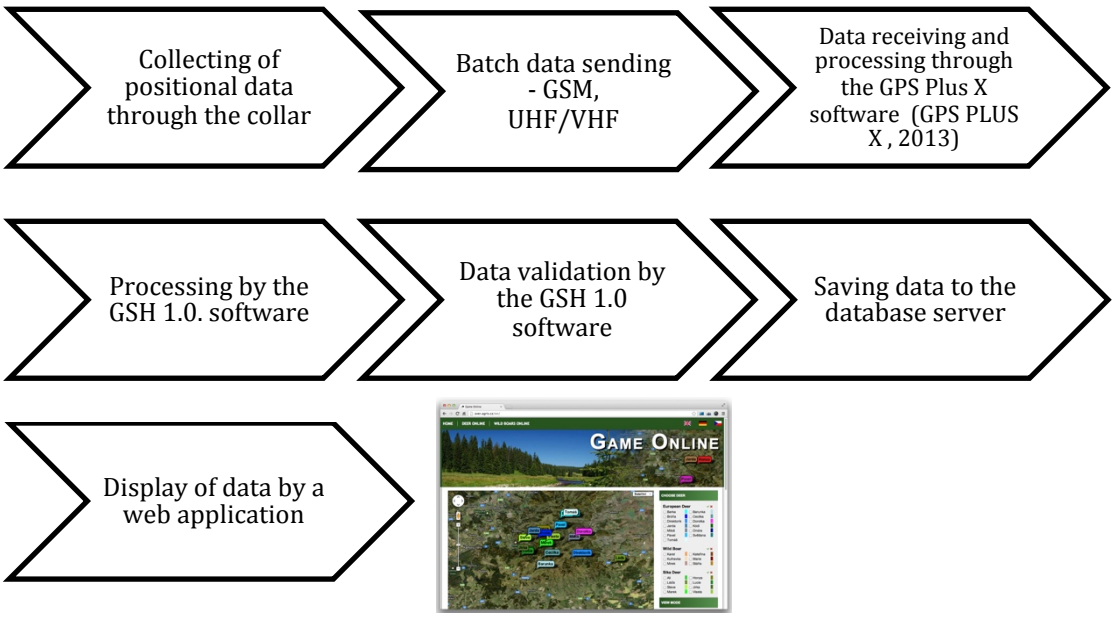

Figure 2. Process of the data collection

3.2.1 Ground Station Harvester

The Ground Station Harvester **(**GSH, 2013**)** software solution has been developed by the Department of Information Technologies Faculty of Economics and Management at the Czech University of Life Sciences in Prague. The application automatically loads the positional data by using the GPS Plus X program (GPS PLUS X, 2013); the load is processed from the ground station device type (e.g.: equipment with GSM communication module for receiving of the positional data from mobile devices – game collars). The obtained positional data is processed - adjusted and cleaned (e.g. validated on the basis of the accuracy of specified position) and then stored on the database server, where the data can be utilized by various other applications (classic, web, mobile). This is a generic software component usable for the collection and validation of the positional data in a range of different fields. The software solution of the web application was released in the standard environment PHP 5 programming language with use of the dBase a the Dibi database layer (Dibi, 2013). The application mainly supports processes in the environment of the MS SQL database server but owing to the utilization of the Dibi database layer, it enables the utilization also in other commonly open database systems.

3.3 Požadavky na webovou aplikaci.

The basic requirements are simplicity of operation; open to the general public and the possibility of browsing of data saved. For the safety reasons (mainly the protection of

animals observed), only selected historical data is shown to the general public. All the historical and current data is available in the internal section of the web application to authorised persons.

3.3.1. Data display

Data can be displayed on-line via web application with a variety of functionalities (visual and statistical outputs):

- Calculation of home range and length of motion path in given time period. (Figure 4)
- Visualization of home range and motion path in given time period. (Figure 3)
- Display of additional textual information about position (such as temperature, or altitude).
- Projection of wild animals´ position in given period (time period and daytime).

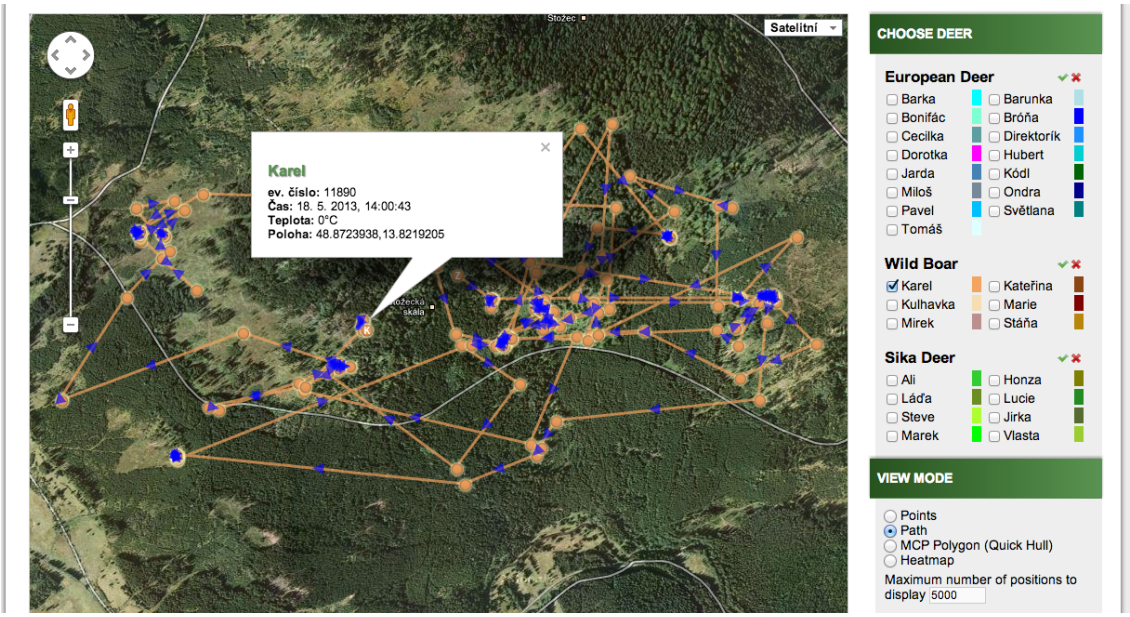

Figure 3. Web application interface motion path of Wild Boar named Karel

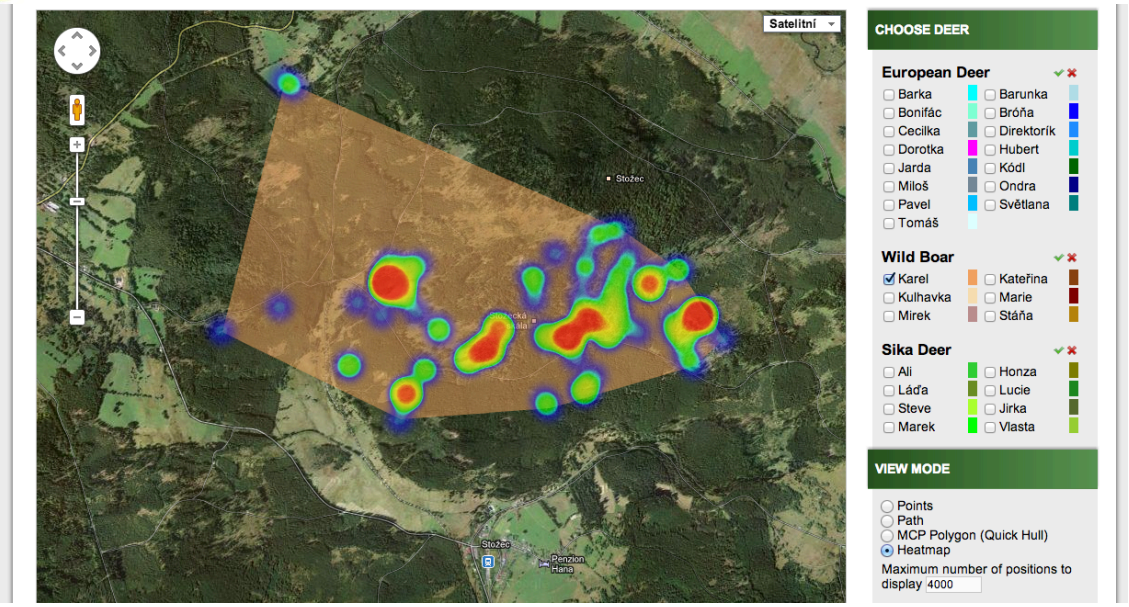

Figure 4. Web application interface home range of Wild Boar named Karel

4. CONCLUSION

The solution has been used for evaluation of spatial activities (via online application) of Sika deer (*Cervus nippon*) and European deer (*Cervus elaphus*) in the area of the Doupovske Mountains. There is being processed also usage for another game - evaluation of spatial activity of Wild boar (*Sus scrofa*) has been being prepared in the Sumava National Park, both in the Czech Republic. The resulting application will enable the usage of validated data in the database for further scientific research and pedagogical purposes and to popularize research results. The solution can be used not only for visualization of spatial activities of various wild animals' species in selected environments, but generally for any monitoring and visualization of moving objects. The presented solution has been further improved and there is a plan for the utilization of this solution in other areas in the future.

4. ACKNOWLEDGEMENTS

Pieces of knowledge introduced in this paper resulted from solution of an institutional research intention. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 20121043, "Sběr a interpretace pozičních dat".

University internal grant agency of the Czech University of Life Sciences in Prague, grant no. 20134312, "Analysis and visualization of GPS telemetry outputs of

cloven-hoofed animals in Doupov Mountains and the Bohemian Switzerland National Park“

The knowledge and data presented in the paper were obtained as a result of the Research Program titled “Economy of the Czech Agriculture Resources and Their Efficient Use within the Framework of the Multifunctional Agri-food Systems” of the Czech Ministry of Education, Youth and Sports number VZ MSM 6046070906.

6. REFERENCES

Dibi - Database Abstraction Library for PHP 5. [on-line], 2013, available: *http://dibiphp.com/en/.*

Fan, F., & Biagioni, E. S. An approach to data visualization and interpretation for sensor networks. 2004. *Paper presented at the Proceedings of the Hawaii International Conference on System Sciences*, 37 999-1008

GSH - Ground Station Harvester 1.0. [on-line], 2012, available: *http://www.agris.cz/kit/gsh/* in czech.

GPS PLUS X . [on-line], 2013, available: *http://www.vectronic-aerospace.com/wildlife.php?p=wildlife_downloads.*

Jarolímek, J., Masner, J., Ulman, M, Ulman, M., Dvořák, S. Cloven-hoofed animals spatial activity evaluation methods in Doupov Mountains in the Czech Republic. 2012. *AGRIS on-line Papers in Economics and Informatics*. 4(3), p. 41 - 48. ISSN:1804-1930.

Krop-Benesch, A., Berger, A., Streich, J., Scheibe, K. Activity Pattern - User's Manual. 2011., *VECTRONIC Aerospace.* Version: 1.3.1 .

Lechner, W., & Baumann, S. Global navigation satellite systems. 2000. *Computers and Electronics in Agriculture*, 25(1-2), 67-85

Nette Framework. [on-line], 2013, available: *http://nette.org/en/* .

Owen-Smith, N., Goodall, V., & Fatti, P. Applying mixture models to derive activity states of large herbivores from movement rates obtained using GPS telemetry. 2012. *Wildlife Research*, 39(5), 452-462.

Stillwell, J., Clarke, G. Applied GIS and Spatial Analysis. 2004 Wiley, Chichester, 420 pages, ISBN: 978-0-470-84409-0

Thanopoulos, C, Protonotarios, V and Stoitsis ,G Online Web portal of competence-based training opportunities for Organic Agriculture. *AGRIS on-line Papers in Economics and Informatics*, 4(1), p. 49 - 63. ISSN: 1804-1930.

Vectronic Aerospace GmbH. Wireless interfaces - GSM bi-directional communication. [on-line], 2013, available: *http://www.vectronic-aerospace.com/wildlife.php?p=wireless_interface.*

C0064
M.Stočes, P.Šimek, J.Vaněk, J.Jarolímek, J.Masner. "Telemetry data collection and visualization – wild animals´ spatial activities in the Czech Republic". EFITA-WCCA-CIGR Conference "Sustainable Agriculture through ICT Innovation", Turin, Italy, 24-27 June 2013.