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Analysing Spatio-temporal Behaviour Data of Free grazing Cattle

Infrastructure and Strategies

In a free-range mountain pasture trial, arranged in the 2007 vegetation period, position and behaviour data of free grazing cattle were collected using different sensor systems. To compile position and temporal information, as well as measured values from different data recorders, a database (DB) was used. Data analysis was carried out completely with the aid of the database. Geographical information system (GIS) and spreadsheet analysis are only used for visualisation.

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Keywords

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In the grazing period 2007, a free-range mountain pasture trial with young stock was carried out within the scope of a research project, funded by the Deutsche Bundesstiftung Umwelt (DBU).

The aim was to test data acquisition and analysis of spatio-temporal behaviour under the conditions of free ranging cattle in a 650 ha pasture area in a National park. Pasture documentation was one of the mainly focused aspects, because grazing damage and soil compaction caused by the cattle play an important role at the chosen area. Of further interest was to what extent the animals are influenced in their grazing behaviour by the widespread windbreak areas (Kyrill) and different environmental parameters.

For these purposes 4 GPS-collars (Vectronic-Aerospace GmbH, Berlin) with integrated GPS-receiver and two-axis-acceleration sensor were used, as well as ALT-pedometers (engineering company Holz, Falkenhagen) for detection of activity (steps), lying time (prone position and lateral position) and ankle temperature.

The position of each animal was recorded every 32 s as a mean value, activity data sets every 64 s in the internal collar storage. The recording interval of the pedometer was 900 s in minimum (*Table 1*). In addition, there were hourly climate data from a meteorological station at the alp. Animals were selected regarding age and group membership.

Problem and objective

During the grazing period from mid-June to mid-September overall 720.000 GPS-, 333.000 activity- and 31.500 pedometer data sets were collected. For the necessary analysis and visualisation of the results, simultaneous processing of geographical and temporal information as well as different sensor data is essential.

The opportunities in unspecific GIS programs or spreadsheet analysis software are not to sufficient for this task or cause a lot of manual data treatment efforts. Objective therefore was to create an infrastructure, that provides storage of the raw data, processing

Table 1: Recording frequencies of collected values and their table assignment in database

Auflösung (in Sekunden) *resolution (in s)*	Größe *parameter*	Tabelle *table*
32	Position *position*	gps
32	Zeit *time*	gps
64	Head up Ratio	act
64	Activity Treshold	act
64	Zeit *time*	act
900	Schrittzahl *steps*	pedo
900	L1 (Liegezeit Bauchlage) *laying time prone-position*	pedo
900	L2 (Liegezeit Seitenlage) *laying time lateral-position*	pedo
900	Knöcheltemperatur *ankle temperature*	pedo
900	Zeit *time*	pedo
3600	Temperatur *temperature*	climate
3600	Niederschlag *rainfall*	climate
3600	Luftfeuchte *humidity*	climate
3600	Windgeschwindigkeit *wind speed*	climate
3600	Windrichtung *wind direction*	climate
3600	Böe *blast*	climate
3600	Zeit *time*	climate

and analysis functionality as well as different arrangements of the results for visualisation in a single easy to manage environment.

Material and method

Technology selection

Because of the requirements, a data base centric solution was pursued. For this, PostgreSQL, an efficient open source data base (http://www.postgresql.org) was chosen. With the PostGIS extension (http://postgis.refractions.net), also spatial information can be stored and analysed, e.g. the processing of tracks out of points, distance calculations or projections. Data processed and stored in the described way can be arranged for different evaluations, exported in csv-data files, analysed in MS Excel and visualised there in diagrams.

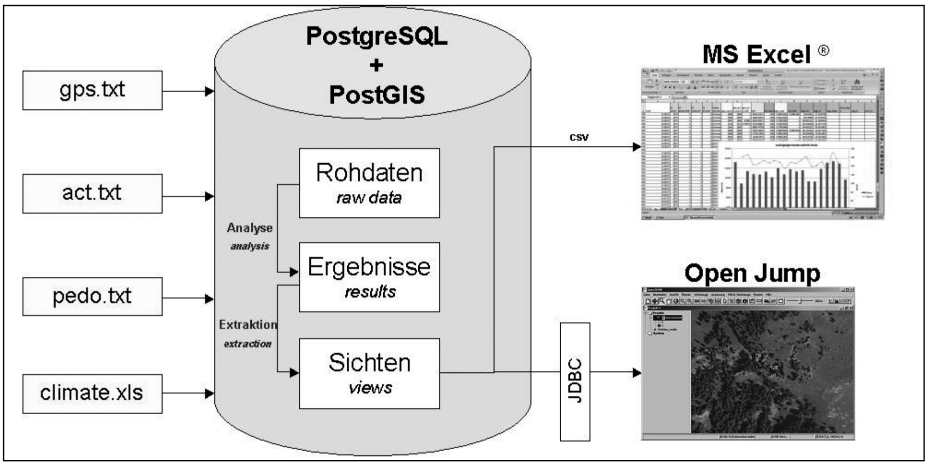

Fig. 1: Data flow and software components

For visualisation of geographical information, the open source geographical information system (GIS) Open Jump (http://openjump.org) is used. In the research project PIROL (http://www.pirol.fh-osnabrueck.de) a lot of helpful tools were developed, which are partly applied here. By means of an additional PostGIS-plug-in (http://sourceforge.net/projects/jump-pilot), data from the database can be loaded and demonstrated via a JDBC-interface. Data arrangements due to the needs of visualisation are done by "views" on the side of the data base (*Fig. 1*).

Data structure

Data sets were stored in separate tables for each data recording unit (*Table 1*). Additionally, total grazing area and areas of special interest (e.g. pasture-, and windbreak areas, watering place) are stored in further tables.

Over the whole trial area, grids with 50 • 50 m and respectively 100 • 100 m were designed. So for each point the assignment to special areas and grids wit data base functions is possible (e.g. analysis example *Fig. 2*). For a fast data access every point (GPS) gets a fixed and indexed reference to every sort of area.

To manage the different recording frequencies of data sets, information was aggregated stepwise. This means, that for each table with higher accuracy, data were completed with aggregation functions (average, sum). Whereas at the level of 32 s per data set only data of GPS are available, they were extended at 64 s with these from the activity sensor in the collar and are completed at the level of 15 min (900 s) with the pedometer data sets. For testing, which recording frequency is sufficient for future applications, additional tables based on hours, days and the whole trial period were compiled. For all parameters minimum, maximum and standard deviation are calculated to allow an overview on the data. For each hour, day and the full trial tracks habitat areas are generated.

Discussion

The use of data base functions for data analysis allows an efficient access to the data. With the extended SQL-syntax of Postgre SQL, algorithms for the solution of complex problems can be developed. This is especially effective for the combination of sensor data with spatio-temporal data from several devices with different recording frequencies. It is not necessary to learn additional programming languages, as they are used for problem description in different GIS. For the visualisation in a GIS, predefined data structures are made available.

In the GIS, only layout has to be adapted to the regarded problem. This is the same for the export to spreadsheet analysis software. Additional information, which is originated by intersections of spatial information (e.g. distances, area attribution) can then be used in those tools, too.

Outlook

Data base centric analysis of spatio-temporal behaviour data is an alternative to data processing in GIS. Especially by the opportunities of automation of the data flow by "rules" and "triggers", nearly autonomous web based systems could be constructed. With adequate network coverage, data of one animal could be transferred (e.g. via GSM) to a server. On a web page or via SMS, figures and maps or events of special interest relating to an individual or the herd can be provided to the farmer. At the same time, analysis about spatial grazing behaviour or soil compaction maps for a single critical area or total regions can be made available to support pasture coordination or nature protection activities.

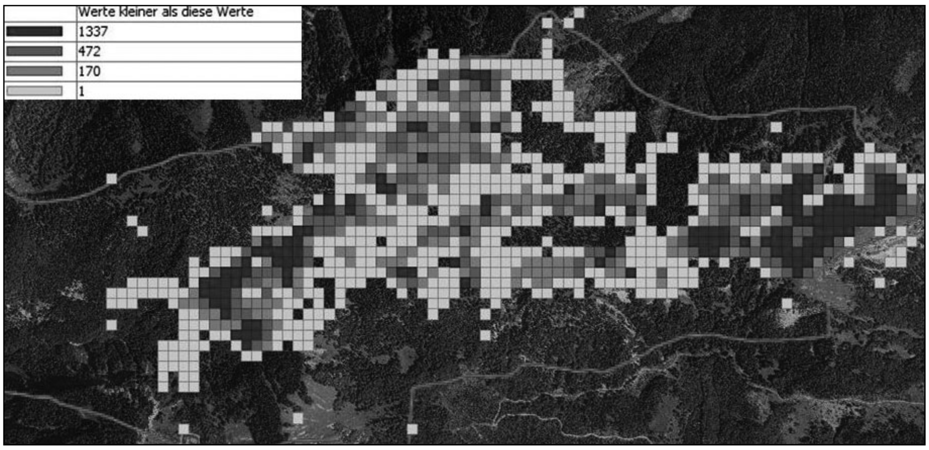

Fig. 2: Whereabouts of all animals in dependency of frequency (50 m • 50 m grid)

Literature

[1] *Braunreiter, C., M. Rothmund, G. Steinberger und H. Auernhammer*: Potenziale des Einsatzes von GPS-Halsbändern für das alpine Weidemanagement. LANDTECHNIK 62 (2007), H. 2, S. 98 - 99

[2] *Braunreiter, C., M. Rothmund, G. Steinberger und H. Auernhammer*: Potentials of GPS-collar application in Pasture Farming. Precision Livestock Farming ´07 - Wageningen Academic Publishers, (2007), pp.87-94, ISBN 978-90-8686-023-4