Agronomy Research **15**(3), 622–628, 2017

Web and android applications for district level nutrient management planning

S. Aksu[1,*], Ü. Kızıl[1], L. Genç[2] and A.M. Yıldız[1]

[1]Çanakkale Onsekiz Mart University, Faculty of Agriculture, Dept. of Agricultural Structures and Irrigation, TR17020 Çanakkale, Turkey
[2]Çanakkale Onsekiz Mart University, College of Architecture and Design, Dept. of Urban and Regional Planning, TR17020 Çanakkale, Turkey
[*]Correspondence: aksusefa@comu.edu.tr

Abstract. Livestock manure, often perceived as a waste problem, is in fact a valuable nutrient source for plants. Besides, it does not only provide nutrients to plants, also improves soil structure, aeration properties and water retention capacity. A district level manure management study was conducted in Çanakkale/Turkey for developing a web based application for animal manure application rates. The procedure and the outcomes of the study were made available for better use of producers. Therefore, a web and an android based application was developed using java programming language coupled with android job package that accessed database for interaction and presentations of the results. The database was created with PHP scripting language to provide soil analysis results (electrical conductivity, pH, lime, organic matter, nitrogen, phosphorus, potassium, iron, manganese, copper and zinc) and manure application rates for major cultivars (paddy rice, maize, wheat, processing and table tomato) within the Gümüşçay district of Çanakkale and uploaded on a server. Then, a browser access interface to specific web page built up with Massachusetts Institute of Technology (MIT) app inventor 2 for android devices and published on official android market.

Key words: GIS, nutrient management, soil mapping, android application.

INTRODUCTION

Land application of animal manure is a widely accepted mothed of manure disposal and a valuable nutrient source for plants. Animal manure rather than saying waste, supplies a complete band of nutrients (nitrogen-N, phosphorus-P_2O_5, potassium-K_2O, etc.) and organic matter required for crop growth and improvement of soil properties (Kessel et al., 1999). Accurate application can improve the soil texture, aeration and hydration capacity in conjunction with enrichment of nutrients (Hillel, 1980). On the other hand, excessive applications may cause yield limitations, waste of nutrients, and impair ground and surface water as well (Kızıl & Lindley, 2001; Sradnick et al., 2014).

Fertilizers are likely preferred by the producers because of their plant available mineral forms. Therefore, limited use of manure compared that generated from animal breeding program may create a huge waste management challenge over time. Consequently, the producer may get rid of this nuisance by quick dumping off the manure in the land leading to an over fertilization or dispose to surface waters. Over fertilization leads to accumulation of immobile nutrients which are transform plant unavailable forms over long-term (KeDong et al., 2013). Likewise, mobile nutrient (primarily nitrate) leakage to groundwater impairs the water quality (Gerhart, 1986) and runoff through surface waters cause eutrophication which leads to a decrease on biodiversity (Hodgkin & Hamilton, 1993).

Determination of manure application quantity requires a delicate and multi-staged calculation. Otherwise, variable nutrient inclusive of manure affects yield negatively and unfavourable environmental impacts can be observed in the vicinity of land application via runoff, leakage and capillary migration (NRCS, 2005). Existing available nutrient content of soil to be fertilized with, nutrient requirements of the crop to be planted for expected yield, and nutrient content of the manure to be applied must be known to calculate optimum manure application rate. Producers are lean to spread manure over the close range fields (Sharpley et al., 1994; Defra, 2004) and as a result of considering only nitrogen content for determination of application quantity, densely accumulated phosphorus in soil texture can be observed (Haygarth et al., 1998).

Crop nutrient cycle is a natural mechanism which operates according to the conservation of energy law. As illustrated in Fig , nutrients transferred from soil to forage crops via vegetative production, then goes to the livestock as feed, and finally return to soil when manure spread over it. Some of the nutrients leave the cycle in different phases as they turn into biomass or under effect of environmental factors. Aim of nutrient recycle program is to sustain the cycle with least loss and nutrient management programs has been designed to achieve.

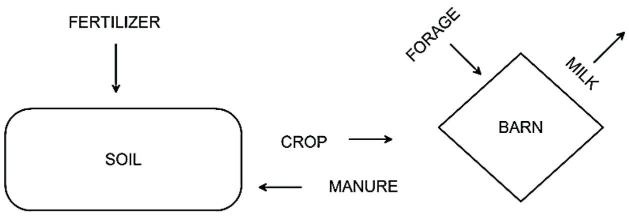

Figure 1. Crop nutrient cycle for dairy farming.

Convenient planning model is applicable to district scale for the territories where livestock and plant production businesses are separated. Fulfilment of nutrient needs in crop production via local livestock production businesses can be sustain within the study areas where regional boundaries were specified for the ease of transportation.

Manure management planning requires to be known the amount of nutrient in soil, depending on location. However, study area must be handled as a whole by the accurate estimations (Basnet et al., 2002). Geographical Information Systems (GIS) can be used for this purpose. GIS, expresses a system which can store and process many qualifier and quantifier data as layers (ESRI, 2010). Also, enables the Cartesian geometry explanations on a geographic position data.

The information, provided from field, has transferred to GIS layers via embedded tools to use as algebraic and statistical calculation inputs. In addition, the visual exposition required to be constituted. However, the complexity originated from third party licensed software has limited the use of knowledge by producers.

Access to internet ratio increases as the increasing use of personal computers and smartphones. Almost every agricultural producer has internet access nowadays. Therefore, producer can have their nutrient application rate in their fingertips if manure management data are available over internet. Therefore, the objective was to develop and test a web based android applications for planning nutrient management.

MATERIALS AND METHODS

This study was conducted in a chosen district to identify potential manure usage on crop fields and provide scientific data to producers over internet. A web page was created using PHP scripting language and all calculations involved with fertilization dose estimation were written in an android programing environment.

Study Area

Gümüşçay District is located 8 km away from the Biga Town, Çanakkale, Turkey (Fig. 2). District has 29,000,000 m^2 agricultural land (TÜİK, 2011).

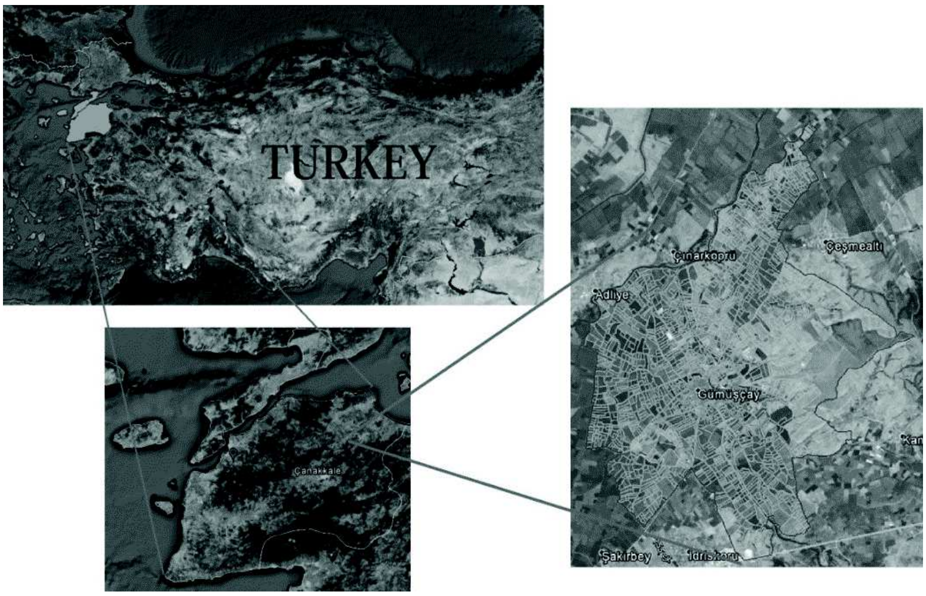

Figure 2. Study area.

According to district directorate of agriculture inventory sheet, there are total 773 milking and 739 heifer cow breeds in this district. Besides, there are 3 different broiler production facilities (poultry) which have a total 250,000 birds. Ovine shelters are located in pasturelands and herd grazing around. Hence, there are no piles of manure exist. Similarly, there is no stored poultry manure accordingly to company contracts. Manure must be stored until its use in a suitable period for a particular plant (crop or forage) production season (Beegle et al., 2000). Therefore, manure amount calculations for the district manure management planning based on bovine.

Quantity of existing nutrients in soil and manure are essential for determining the dosage of animal manure and chemical fertilizer application. Existing digital soil inventory data was obtained from a previous study (Aksu & Kızıl, 2015) and integrated with the animal manure dose estimation algorithm in accordance with the purpose of this research. Quantity of nutrients in animal manure right before application is an another factor to be considered for sound manure management planning (Chescheir et al., 1985). Total amount of nutrients in manure which produced within the district must be accurately determined. In this research, animal manure samples collected from commercial barns were analyzed before estimating application dose. Later on, manure nutrients data was uploaded to a particular location (Web Address) to be integrated with fertilizer dose calculation tools (algorithm) develpped in this research.

Coding Software

Internet based application was chosen because of its easy access, which facilitates user friendly web development and database processing tasks. Simple C# and C++ codes were used to create Hypertext Pre-processor (PHP) web development project. This project was the core of web based applications that linked and processed databases. Project database allows uploading of updated soil inventory, manure application rates, maps as images, and filtering attribute table. On the other hand, android applications are written in java programing language which utilize android job packages. Another method to create android applications is combining logical blocks (Fig. 3) with help of MIT App Inventor 2 (Massachusetts Institute of Technology, Massachusetts, USA). This engine has few benefits namely, it is free of charge, fast response on emulators, and easy online library access. Hence, it eases coding for java and chosen to create android application. Both of the applications connects nutrient management database to retrieve requested info.

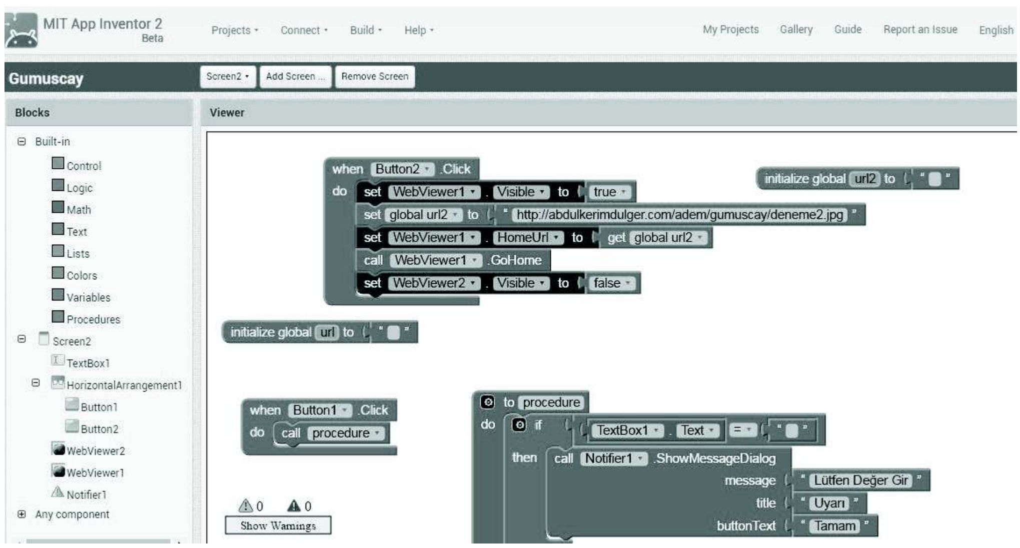

Figure 3. MIT App Inventor logic blocks design.

Method

High definition satellite image covering the target district was clipped from an open source map application. A parcel border layer was added to image and labelled according to parcel numbers that obtained from the Gümüşçay Municipality Civil Works Department. Visualisation of application has prepared by this manner.

Soil nitrogen content of district, nutrients content of the manure and chemical fertilizer, and nitrogen requirement of a crop were used according to the Eq. 1 (MWPS, 1993).

$$N = \frac{\mathrm{N}_{need} - N_{soil}}{[\mathrm{N}_{\mathrm{total}} - (N_{ammonium} + N_{nitrate})] * 0.3 + N_{ammonium} + N_{nitrate}} \qquad (1)$$

where: N – nitrogen application; N_{need} – cultivars nitrogen need; N_{soil} – soil nitrogen content, N_{total} – manure total nitrogen content; $N_{ammonium}$ – manure ammonium nitrogen content; $N_{nitrate}$ – manure nitrate nitrogen content.

Soil inventory data and manure application rates for manure and mineral fertilizer were combined into one MS Excel file and organized according to parcel numbers. That was how this manure nutrients database was created, uploaded, and integrated with web based application for determining manure application rates.

RESULTS AND DISCUSSION

All collected and created data uploaded to web server to publish. The web page can be reached at 'http://abdulkerimdulger.com/adem/gumuscay/exread.php'. Users can search the parcels either enlarging the map on the screen or typing parcel number. Application shows the physical characteristics, soil inventory data and manure application rate (according to major cultivars) when 'bring values' button pushed (Fig. 4).

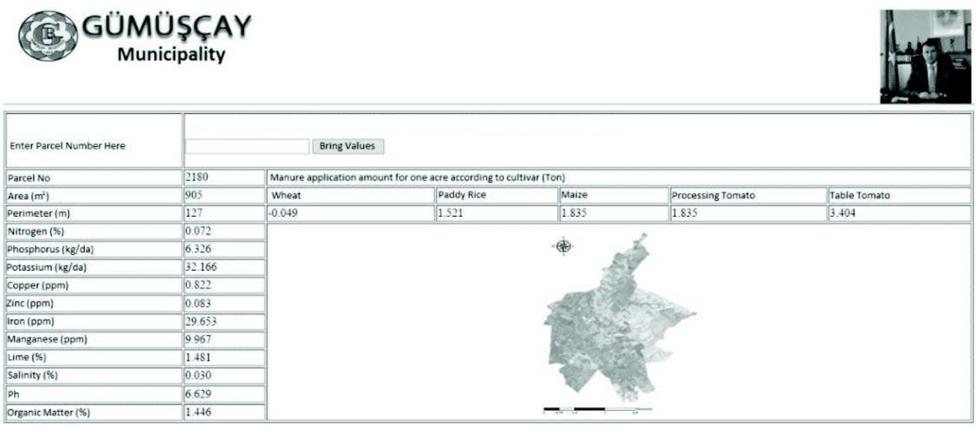

Figure 4. Web application user interface.

The main aim of the project is to serve producers. Therefore, this web based manure application tool was linked along with the description of applications to the official web page of Gümüşçay Municipality. Web based application can be used in mobile devices (smartphones, tablets, etc.) through embedded browsers. But some versions of browsers might encounter page resizing difficulties. Thus an android application has created and published on official Android Market (Fig. 5).

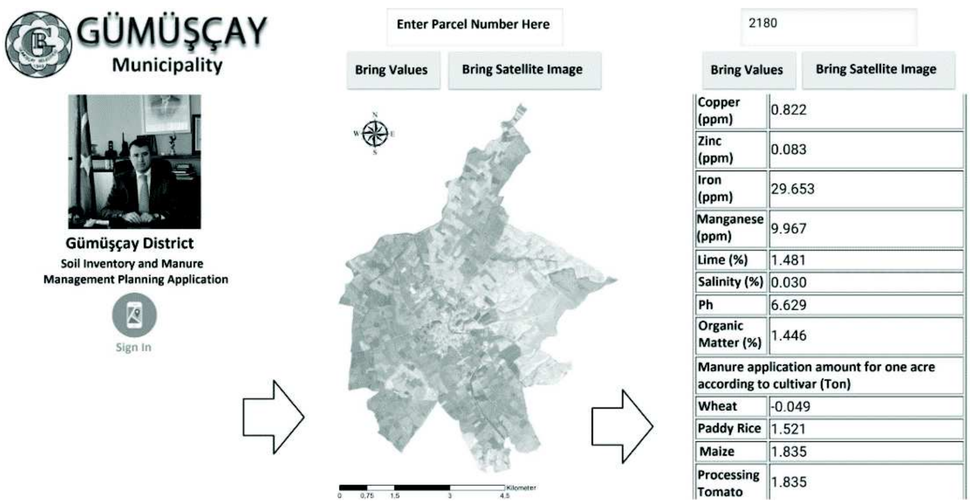

Figure 5. Android application user pages.

Android application is providing a secure path to web application database and the working procedure is the same way. The performance of this application is highly satisfactory and whole system worked without any problem, even if database was updated periodically. Especially soil inventory data varies under the influence of many factors like cultivar variety, tillage method, irrigation method, etc.

CONCLUSIONS

Use of smaller animal manure originated from stockbreeding has increased the use of mineral fertilizer for crop production. This situation has created a critical animal waste management problem for stockbreeders and thus a pollution thread to the environment. Within this context, animal waste management became an important issue, especially for big businesses. In addition, it will be inevitable to take precautions about manure originated environmental problems for Turkey through the European Union adjustment process. However, it was postulated that the lack of knowledge and experience about manure management in big businesses, not even exist for almost every small scale business. Study has conducted either to fulfil of knowledge lack about manure management or reveal an applicable model.

ACKNOWLEDGEMENTS. Special thanks to Gümüşçay Municipality for supporting this project. We would also like to thank Taşoluk Dam Irrigation Association for their assistance during the field work.

REFERENCES

Aksu, S. & Kızıl, Ü. 2015. Developing a Town Based Soil Database to Assess the Sensitive Zones in Nutrient Management. *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering* **9–8**, 818–823.

Basnet, B.B., Apan, A.A., Raine, S.R. 2002. Geographic Information System Based Manure Application Plan. *Journal of Environmental Management* **64**, 99–113.

Beegle, D.B., Carton, O.T., Bailey, J.S. 2000. Nutrient Management Planning: Justification, Theory, Practice. *Journal of Environmental Quality* **29**, 72–79.

Chescheir III, G.M., Westerman, P.M. & Safley, Jr. L.M. 1985. Rapid Methods for Determining Nutrients in Livestock Manures. *Trans ASAE* **28**(6),1817–1824.

Defra. 2004. Mapping the Problem. Risks of Diffuse Pollution From Agriculture. London, UK.

ESRI. 2010. ArcGIS 10 Help.

Gerhart, J.M. 1986. Ground-Water Recharge and its Effects on Nitrate Concentration Beneath a Manured Field Site in Pennsylvania. Ground Water July-August 1986, vol. 24, no.4.

Haygarth, P.M., Chapman, P.J., Jarvis, S.C., Smith, R.V. 1998. Phosphorus Budgets for Two Contrasting Grassland Farming Systems in The UK. Soil Use Manage 14:160–7.

Hillel, D. 1980. Application of Soil Physics. Academic Press, New York.

Hodgkin, E.P. & Hamilton, B.H., 1993. Fertilizer and Eutrophication in Southwestern Australia: Setting the Scene. *Fertilizer Research* **36**, 95–103, Kluwer Academic.

KeDong, A., Jing, Z., DangYang, Z. 2013. Estimation of Phosphourus in Livestock Manure And its Pollution Risk Regionally. *Journal of Henan Agricultural Sciences* **42**(8), p.53–56.

Kessel, J.S., Thompson, R.B. & Reeves III., J.B. 1999. Rapid On-Farm Analysis of Manure Nutrients Using Quick Tests. *Journal of Production Agriculture* **12**(2), 215–224.

Kızıl, Ü. & Lindley, J.A. 2001. Comparison of Different Techniques in The Determination of Animal Manure Characteristics. ASAE/CSAE North Central Sections Conference Brookings, South Dakota. p. SD 01–106.

Midwest Plan Service (MWPS). 1993. Livestock Waste Facilities Handbook, 112 pp. ISBN: 0-89373-089-0.

NRCS, 2005. Applying Manure in Sensitive Areas. Minnesota Pollution Control Agency and USDA Natural Resources Conservation Service.

Sharpley, A.N., Chapra, S.C., Wedepohl, R., Sims, J.T., Daniel, T.C. & Reddy, K.R., 1994. Managing Agricultural Phosphorus for Protection of Surface Waters: Issues and Options. *Journal of Environmental Quality* **3**, 437–51.

Sradnick, A., Oltmanns, M., Raupp, J. & Joergensen, R.G., 2014. Microbial Residue Indices Down the Soil Profile After Long-Term Addition of Farmyard Manure and Mineral Fertilizer to a Sandy Soil. Elsevier Ltd, Oxford, UK, *Geoderma* **226–227**, 79–84.

TUİK, 2011. Turkish Statistical Institute, Annual statistics.