A New Sensor-Based Spatial OLAP Architecture Centered on an Agricultural Farm Energy-Use Diagnosis Tool

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ABSTRACT

Agricultural energy consumption is an important environmental and social issue. Several diagnosis tools have been proposed to define indicators for analyzing the large-scale energy consumption of agricultural farm activities (year, farm, production activity, etc.). In Bimonte, Boulil, Chanet and Pradel (2012), the authors define (i) new appropriate indicators to analyze agricultural farm energy-use performance on a detailed scale and (ii) show how Spatial Data Warehouse (SDW) and Spatial OnLine Analytical Processing (SOLAP) GeoBusiness Intelligence (GeoBI) technologies can be used to represent, store, and analyze these indicators by simultaneously producing graphical and cartographic reports. These GeoBI technologies allow for the analysis of huge volumes of georeferenced data by providing aggregated numerical values visualized by means of interactive tabular, graphical, and cartographic displays. However, existing data collection systems based on sensors are not well adapted for agricultural data. In this paper, the authors show the global architecture of our GeoBI solution and highlight the data collection process based on agricultural ad hoc sensor networks, the associated transformation and cleaning operations performed by means of Spatial Extract Transform Load (ETL) tools, and a new implementation of the system using a web-services-based loosely coupled SOLAP architecture to provide interoperability and reusability of the complex multi-tier GeoBI architecture. Moreover, the authors detail how the energy-use diagnosis tool proposed in Bimonte, Boulil, Chanet and Pradel (2012) theoretically fits with the sensor data and the SOLAP approach.

Keywords: Energy-Use Indicators, Sensor Network, Spatial Data Warehouses, Spatial Extract Transform Load (ETL), Spatial OnLine Analytical Processing (SOLAP)

DOI: 10.4018/ijdsst.2013100101
1. INTRODUCTION

Agriculture energy consumption depends on the method of production used. Direct agricultural energy consumption was estimated to be 28 Mtoe of a total consumption of 1142 Mtoe, which was 2.5% of the energy directly consumed by the EU25 in 2004 (SOLAGRO, 2007); 55% of this energy was the result of fuel consumption. With the planned reduction in oil and rising oil prices, agriculture must reduce energy consumption to improve its economic development and decrease its environmental impact. Awareness of the importance of preserving nonrenewable energy resources is increasing, as evidenced by the energy development policies adopted in recent years by different governments (Energy Policy of 2005, the Grenelle Environment, etc.). Applied to the agricultural context, this reality requires a better assessment of the energy balance of farms in terms of energy performance. At present, many diagnosis tools exist that define a set of indicators to assess the energy performance of agricultural farms (Pradel & Boffety, 2012). These diagnoses, which are specifically adapted to conducting a comprehensive assessment at the farm scale, are not necessarily relevant to evaluating the energy performance at a detailed scale (plot, technical operation, etc.). Thus, in this paper, we present a theoretical diagnosis framework with new appropriate indicators to analyze the energy-use performance of agricultural farms at a more detailed scale (plot, technical operation, etc.). Thus, in this paper, we present a theoretical diagnosis framework with new appropriate indicators to analyze the energy-use performance of agricultural farms at a more detailed scale (plot, technical operation, etc.). 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