GEOGRAPHIC INFORMATION SYSTEMS A JUSTIFICATION FOR THEIR USE IN GEOTHERMAL DEVELOPMENTS

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ABSTRACT

Very large amounts of information are generated in almost all aspects of geothermal development and advancements in information technology can now provide additional options for the preparation of documentation and the manupulation and assessment of data and other information.

Geographic Information Systems (GIS) could be used to develop the process of referencing relevant information. This could include organizing available data, locating specific information, executing computations, illustrating important features and performing analyses. GIS offers the advantage that it can process quantities of data far beyond the capacities of manual systems. Data in GIS are stored in a uniform, structured manner, as opposed to manual systems in which the data are usually stored in various archives and files, on various maps or in long reports.

1. INTRODUCTION

Widespread interest in reducing the emission of green house gases provides a strong incentive to continue and expand the development and utilisation of geothermal energy.

A geothermal development programme can be separated into four main processes; exploration, reservoir development, utilisation, and electricity generation. In terms of investment there are three elements; the production of steam, its transmission from well to power plant, and its conversion into electricity in the power plant. (Goldsmith K, 1975). Since much of the expenditure during the exploration stage is incurred before a steam supply becomes assured, the costs for the first two elements can be very uncertain.

Geographic Information Systems are the result of a marriage between Computer Assisted Cartography (CAC) and Database technology. GIS could be applied in geothermal developments to assist decision-making, assess spatial data and disseminate information, thus improve the efficiency of the operation.

2. GIS DESCRIPTION

Georeferencing is usually expressed in terms of position in cartesian coordinates or in latitude and longitude. A GIS can process and perform spatial analyses of georeferenced data to identify spatial relationships and the dependence of interpretations upon the weighting of conflicting or uncertain parameters.
GIS can process data from dissimilar sources, including digital map data, digital images, computer-aided design (CAD) data and various computer-based registers, such as "data mixing systems" or global positioning systems. (GPS).

GIS data are usually stored in databases in ways that permit new in-sights, particularly into the relationship between dissimilar entities. A database is a comprehensive collection of related data stored in logical files and collectively processed.

GIS offers the advantage that it can process quantities of data far beyond the capacities of manual systems and allows data to be retrieved, superimposed rapidly and quickly compiled into documents using automatic map making and direct report file/print output facilities.

The application of GIS in improving the efficiency and effectiveness of geothermal developments lies in the creation of a spatial data multi-layer analysis map.

3. JUSTIFICATION AND BENEFIT

The implementation of a GIS is a costly, long-term undertaking and an implementation plan is likely to be required, containing the justification for its use.

The way a GIS acquisition is justified will directly affect the steps needed to successfully implement it and the budget that can be obtained. (Aronoff S, 1989).

Deciding whether or not to proceed can be greatly assisted by a systematic and quantitative analysis of the expected costs and benefits. Some of the more commonly recognized benefit of a GIS are :

1. better storage and updating of data
2. more efficient retrieval of information
3. more efficient production of information products
4. rapid analysis of alternatives, and
5. the value of better decisions.

However, the decision to implement a GIS system will rarely be justified on the grounds of costs and benefits initially. In principal, a comparison of the benefits of an existing system and a proposed GIS should provide solid data to support the decision to implement a GIS. The problem is that a good deal of judgement must be exercised in deciding how to define and measure those benefits. The items selected for measurement and the way they are quantified directly affects the result. (Aronoff Stan, 1989).

The benefits are the more difficult to quantify, Three types of benefits need to be considered:

1. *The benefit of increased efficiency*, The more efficient system will require less resources to perform an operation. This type of benefit is generally measured for existing tasks, such as producing a map or generating report.

2. *The benefits of better decisions.* More accurate information and faster, more flexible, analysis capabilities can improve the decision-making process itself.
3. *Intangible benefits.* These benefits may include better communication within the organization, improved morale, and a better public image. Though not directly quantifiable these benefits can also have direct and important effect on the efficiency of the organization.

Although some form of cost-benefit analysis is generally used to help justify a GIS acquisition, a leap-of-faith is commonly needed as well.

4. IMPLEMENTATION

An implementation plan should be developed to show how technology, information, and people will be molded into an operation information system. The fundamental challenge is that all three of these factors must work together and this requires a significant investment of time and money to bring each one into operation.

Implementing a GIS and the creation and integration of the database involves organizing data and converting it into suitable digital form. However, the database is in a very real sense a valuable asset. Not only is it valuable for the data it contains, but the conversion process should add value because the data becomes more accessible, usable for a wider range of applications, and have improved accuracy. In addition, the database has the potential to increase in value more quickly because it can be more easily maintained and allows the relatively straightforward correction of any data that are inaccurate or incorrectly entered.

The system as a whole is an integration of all those steps necessary to make the individual components perform together as specified.

5. MAINTAINING DATA QUALITY

The quality of data should be maintained and three issues should be considered.

1. *Accuracy of content*. The degree to which the data represents the condition they describe. Information provided in a standard form, widely distributed and commonly used, makes it possible to presume standard levels of information quality and standard levels of knowledge among users.
2. *Accuracy of context.* An assertion is being made about the inter-relationship between map elements. Even though the content of each data set may be correct, when the data from different sources are presented together as a map, the information conveyed can be quite misleading.
3. *Data format*. Changing the format can significantly alter the consequences of distributing the information and the data should be easily and quickly searched for matching data sets that have common data fields. The procedure can be used to relate data from files that were not intended to be used together.

GIS systems are already employed in a wide range of projects including geothermal developments, airport planning, and the like. However, they have typically been used not for an entire project, but only for parts of it, as overview planning, optimising, visualising, and so on.

Geothermal developments involve many disciplines which need information on geology, geophysics, geochemistry, environmental, land use, and resource data. All the relevant data can be entered in a central map database, which then supports design.

Development can divided into two stages; exploration and exploitation, each with a map, which delineates what has to be done. All computations requiring georeferenced parameters can be executed rapidly, as all the information is available from the central database. Maps can be continuously produced to meet the needs of various design tasks.

This process offers numerous advantages, including :

- The stage maps that illustrate progress can be both more detailed and geometrically more correct, which eases further design.
- Errors and omission can be more rapidly located, as all information is available in the central database.
- Interactive design of pipe-line, road, transmission-line, with access to all georeferenced information, saves considerable time compared to conventional design.
- Appreciable time is also saved in all computations of coordinates, distances and other parameters, as well as in superimpositions and drawing.
- All completed works are measured, and measurements are entered in the system, which permits rapid verification against plans. When the project is finished, a complete description of the station area is available in the database.
- Projects with tight deadlines will benefit from concise data structuring and precise dataflow.

6. CONCLUSION AND DISCUSSION

Graphical Information Systems comprise spatial data with georefernece information about particular features. They could provide the capability to associate information with a feature on a map and to create new relationships that can determine the suitability of various potential sites, evaluate environmental impacts and identify prospect areas. Increased efficiency and effectiveness in these areas is one of the requirements for more effective and efficient achievement in geothermal developments as a whole.

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