

GEOHERMAL MONITORING

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SUMMARY - Under the Resource Management Act (RMA) it is mandatory that local authorities “monitor” the “environment” (RMA section 35). However, although “environment” is defined in the Act, the activity of monitoring is not. This therefore leaves the interpretation of monitoring to the discretion of the individual local authorities.

This paper discusses a possible interpretation of monitoring and its function in the management of natural resources. As a case study, the interpretation is applied to the monitoring of a geothermal resource.

1 INTRODUCTION

The activity of monitoring has been a point of discussion for some years. In geothermal management we have seen the Rotorua monitoring programmes. In the past local authorities have indulged in activities that they claim to be monitoring, and monitoring has been mentioned in water right conditions. In many cases this monitoring activity has generally been little more than a data collection exercise.

Now, under the Resource Management Act (RMA) (section 35), it is mandatory that local authorities “monitor”:

35. Duty to gather information, monitor, and keep records—

- (1) Every local authority shall gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act.
- (2) Every local authority shall monitor—
 - (a) The state of the whole or any part of the environment of its region or district to the extent that is appropriate to enable the local authority to effectively carry out its functions under this Act; and

- (b) The suitability and effectiveness of any policy statement or plan for its region or district; and
- (c) The exercise of any functions, powers, or duties delegated or transferred by it; and
- (d) The exercise of the resource consents that have effect in its region or district, as the case may be,—

and take appropriate action (having regard to the methods available to it under this Act) where this is shown to be necessary.

RMA defines the environment to be:

- (a) Ecosystems and their constituent parts, including people and communities; and
- (b) All natural and physical resources; and
- (c) Amenity values; and
- (d) The social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters.

However, the RMA does not define monitoring.

This paper specifically addresses the *appropriate monitoring of the natural and physical resources as*

a resource management tool. Monitoring in this instance is not an isolated activity, instead it requires prior research and characterisation of the resource, and identification of critical variables. And it requires supporting management procedures for dealing with situations when these critical variables exceed predefined bounds.

2 GEOTHERMAL RESOURCE CHARACTERISATION

In general, the state of a resource can be determined by using an optimum set of variables that are accessible to physical measurement. This variable set is usually identified as part of the characterisation of the resource which is undertaken during an initial research period. Resource characterisation includes a detailed study of the resource, the acceptance of a model, the identification of critical variables, and an assessment of their range of variability. Continued research may optimise the variable set.

Management of a resource requires some knowledge about its initial state and the identification of a future desired state. Identifying future states may not be easy because of the range of time scales of natural changes.

Part of the establishment of the management structure, is the determination of objectives. These objectives define the desired state of the resource and the path by which the resource is to be changed from the initial to the desired state. The objectives might also set limits for selected variables.

With this structure in mind, it is proposed that resource monitoring is (refer figure 1):

- the measurement of a previously identified optimum set of variables,
- the checking to ensure that the selected variables do not exceed prescribed limits, and
- the insertion of the variable values into the chosen working model to ensure that it continues to be an acceptable match to the resource.

In the establishment of the monitoring system, there needs to be a provision for its regular review. This allows newly acquired information to be used to optimise the monitoring and ensures that management's monitoring requirements are satisfied. The interval between reviews will obviously be dynamic and dependent upon the knowledge of the resource.

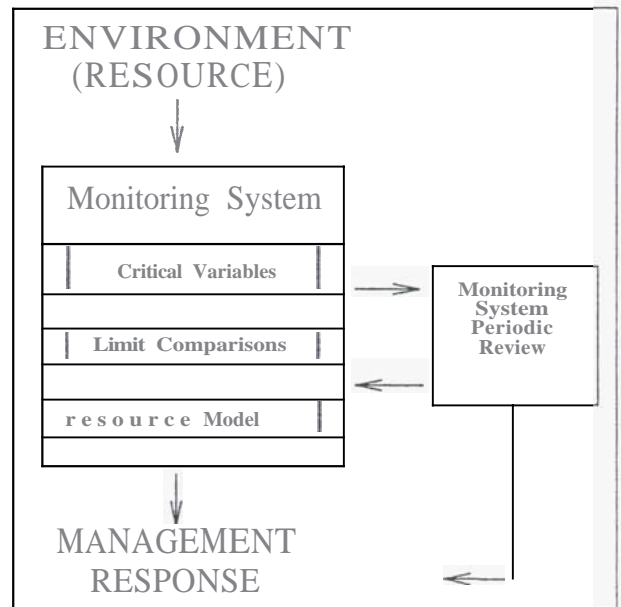


Figure 1: Functional diagram

3 THE VARIOUS ROLES

The role of the regional councils, as defined in the RMA (sections 30 and 14), is that of the resource manager, with a specific directive to monitor the environment

... to the extent that is appropriate to enable the local authority to effectively carry out its functions under the Act (RMA section 35 (2)).

It is obvious that the local authorities (regional councils and territorial authorities) will generally not have the necessary specialist personnel able to directly undertake the research and characterisation of the resource. Instead other organisations can be commissioned to do this work (RMA section 35 (1)).

Where measurement of critical variables requires specialist equipment and operator experience, or it is more *cost-efficient*, then the data collection function of monitoring might also be undertaken by other organisations. However, the data must be scrutinised and interpreted in order to determine whether the management objectives are being met. The local authority will need to do this and decide whether further action is necessary.

As part of the data interpretation, the data should be used to check the working model. If there is a significant deviation between the two, then it may be necessary to consider alternative resource models. Again this could be undertaken by other organisations.

4 INFORMATION

Resource information is obviously essential for the responsible management of a resource. A considerable amount of resource information is derivable from general monitoring and data collected as part of resource consents.

Subsections 35 (3) and (5) (k) of the RMA combine to require that the local authorities keep available for public perusal, among other things any information gathered as part of a resource consent or monitoring activity.

Resource monitoring results in the collection of data. However, data may not be information. Instead, information is derived from the interpretation of data. For example, a sequence of numbers could be data, but until we know about the number generator we can not claim that the data conveys information.

If monitoring measurements are made by the resource users or a third party, then the question arises as to what local authorities should expect from resource monitoring and conditions placed on resource consents. Do they request reports, which are an interpretation of data, and/or do they request raw (or reduced) data with the appropriate generator details? Obviously if the measurements are made by the authority staff then this is not such a problem, but if made by others commercial sensitivity could be an issue (though this will require support).

It is possible that a consent holder may be required to sample the critical variables and have measurements available for local authority perusal. The argument might be made that though these data are being collected as part of the consent conditions, they are not information and therefore do not have to be made available to the public. Once the data have been interpreted or included in a report then they are information.

A related issue is the interpretation of the data. Many models can be constructed to fit a given data set. Therefore, responsible management requires that reports and the underlying data are available for independent review.

5 MONITORING A GEOTHERMAL RESOURCE

Consider a geothermal field as an example of resource monitoring. The first step in managing the field is to determine its extent and other characteristics. This requires research from a number of disciplines e.g., geophysics, geology, geochemistry, hydrology, biology and ecology. The outcome of the research should lead to: a description of the initial state of the resource and its environs; a range of possible final states; and a selection of development paths. These are effectively the possible management objectives and policies that give rise to a range of scenarios.

The next step is the selection, made with public consultation, of a desired scenario and the accompanying management objectives and policies. Having decided upon a desired state for the resource and the path to this state the critical variables can then be selected. These variables might include the fluid enthalpies from a set of bores or the measurement of the macroinvertebrate community present at selected stream sites. The periodic sampling of these variables enables the field managers to track the change of resource state from the initial to the desired state and to determine the divergence from the desired development path.

Management objectives need to include a time by which the desired state should be achieved. This in turn determines the acceptable rates of change of the critical variables.

The change in resource state needs to be undertaken in a way that minimises various impacts. In the utilisation of the resource, two types of impacts might be considered. The effects of utilisation on the resource and the effects of utilisation on the resource's environs, i.e., the internal and external effects. Hence, the assessment of impacts is a prerequisite of the monitoring.

The management structure must also contain procedures for dealing with instances when the critical variables exceed their prescribed bounds. A range of procedures will be required to cope with delayed responses, nonlinear effects and natural variability within the resource.

6 EXAMPLE: SUBSIDENCE

As an example of a possible geothermal resource use impact that might need monitoring, consider subsidence. Experience has indicated that extraction of

geothermal fluid may lead to ground subsidence. The consequences of this include ponding in streams and rivers, the distortion of buildings, and the stressing and possible fracture of pipes. Such impacts could have serious implications in urban and industrial areas.

If subsidence is a likely consequence of developing a geothermal field then an assessment is required of the acceptable subsidence effects. The assessment should:

- identify the subsidence variables (e.g. the rate of slumping, and the total subsidence),
- establish an acceptable operational range for these variables,
- recommend a programme of surveillance for an optimum set of these variables including sampling frequency and measurement accuracy, **and**
- recommend procedures for dealing with instances when a monitored variable exceeds its acceptable range, e.g., change in the location of the injection or extraction points, reduction in rate of extraction.

Once these steps have been completed then subsidence monitoring can begin. This monitoring would entail the:

- periodic measurement of the critical variables, e.g, by levelling a predefined array of points,
- scrutinising of the data to check that the measured variables are within the permissible range, that the rates of change are acceptable, and
- comparison of the predictions of the subsidence model against the data.

7 WAIKATO REGIONAL COUNCIL

The Waikato Regional Council is in the process of establishing a management structure for the different scales of the region's geothermal resource. An outcome of this process will be directions on how monitoring may be used to help manage the resource. The above approach is an interpretation that is presently being considered by the council.

The users of the geothermal resource will be required to make a contribution towards this monitoring in proportion to their use. As well, in some situations, it is possible that they will be required to do the initial research.