Visualising information
The potential to communicate sustainability

Barbara Hock and Tim Payn

Forestry is important to New Zealand's economy. In addition, plantations also contribute social and environmental benefits to the nation, including mitigating climate change. For these benefits to continue, forestry needs to be practised sustainably. Sustainable forest management can be defined as –

> The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems (MCPFE 2011).

The need to demonstrate forest sustainability underpins New Zealand's international reputation as demonstrated by Montréal Process reporting and international commitments such as the Kyoto Protocol. Certification of forest management through the Forest Stewardship Council is a requirement for access to some of the international markets.

Sustainability includes many social, environmental and economic components which are potentially complex, to measure, model and understand, in their own right as well as in their interaction with one another (Johnson & Chess, 2006). For example, two forest sustainability frameworks in New Zealand – the Montréal Process and FSC certification – consist of seven criteria and 54 indicators, and 10 principles and 56 criteria, respectively. New Zealand's 2008 Montréal Process report indicates that the quality of information for a number of indicators is low.

No trivial matter

Therefore, getting an overall picture of the state of forests and understanding their sustainability is not trivial for those involved with New Zealand's forestry. These include central and local government, communities of interest including the general public and NGOs, as well as those in the industry itself and in forestry-related industries, and the national and international consumers of the forestry products.

This information needs to be communicated clearly to produce a picture of the overall state of the forests and trends of interest. There are many ways to do this, but often the information is presented as a thick written report, which is not the best possible approach. Nevertheless, forest growers need to be able to demonstrate the sustainability of their forestry practices to a level which is understandable and endorsed across the diverse groups (Raison, Brown, & Flinn, 2001). This article covers the communication methods commonly used for forest information flows, and focuses on new opportunities to use visualisations to help with this communication.

Communicating sustainability information

Communication on forest sustainability can take the form of one-way flow from sender to receiver, including dissemination of information, leaflets, marketing, posters, scientific publications and presentations. This is the traditional mechanism used, and a New Zealand example is the series of Montréal Process country reports.

A degree of frustration is often expressed by both presenters and recipients of this type of information, in that concise and easy-to-read overviews require a level of trust in the skills of the summarisers. On the other hand, detailed reports can be difficult to comprehend and use effectively.

Two-way communication provides for responses, questions and clarifications, making this the more accurate communication approach, resulting in better understanding (Fiske, 1990). This ranges range from conversations, workshop and meetings, to social web approaches. Examples of the latter are open and closed professional internet sites or discussion groups, such as LinkedIn's sustainability professionals.

Communication needs to build on what people know and address what they value, and their different levels of expertise and information needs. Information on the benefits of forestry, such as a visual display of volume growth, are accessible to many. However, the processes and services of forests and effects of forest operations on such processes and services may require more explanation.

Forestry-related communication includes public consultations, the dissemination of new understanding and of monitoring information, reports on the sustainability of New Zealand forestry, and plans for councils and the Environment Court. Important research issues for the field of communication are –

- The acceptance or rejection of a form of communication
- The roles of organisations and individuals in communication, including such influences as trust and power.

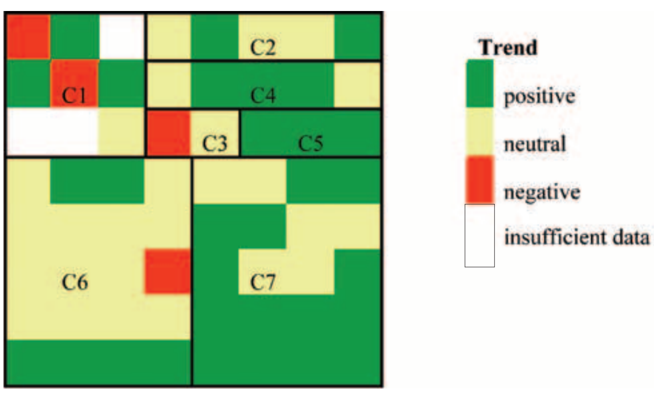
Display of volume growth with inscription 'This amount of wood grows in our forest in 1 hour' by the German state Baden-Wurtemburg

A picture is worth a thousand words

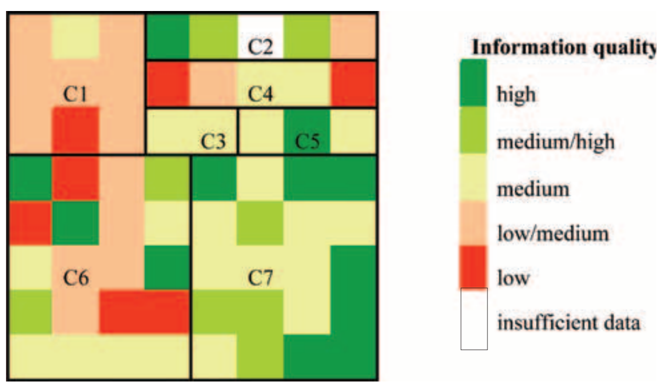
Visualisation techniques offer advantages over traditional approaches to understanding and communicating sustainability for a wide range of data, although they are perhaps not as frequently used as is warranted by their effectiveness. They have the ability to convey a range of messages quickly and powerfully, as recognised by commercial advertisers and the media and political and marketing campaigns.

Research supports this with images shown to have the potential to improve cognition, influence decision-making and change behaviours. The ability for visualisations to be very persuasive, to be beneficial for developing knowledge, to help collaboration, and for presenting information in ways that are easy to understand have made them useful tools in environmental discussions. For example, Zimmerman et al (2006) demonstrated the importance of visualisations for communication on forestry model outputs.

Take the example of the New Zealand Montréal Process 2008 report. Simple summary visualisations of the trends and data quality for each indicator using the green-is-good, red-is-bad traffic light approach give a swift overview of the sustainability of our forests. This approach also allows easy comparison between two



Montréal Process criteria and indicators coloured according to the trend in 2008 – a representation which gives a quick impression of the overall balance of indicator trends



Montréal Process criteria and indicators coloured according to the quality of the data in 2008 – this representation enables the viewer to better interpret the overall trends in the data based on confidence in data quality visualisations. In this example, showing that while this trend is frequently positive, the data quality can often be low. This snapshot approach can then be followed up by further examination of the report's detail on an individual indicator basis.

Increasing dimensions

Graphs, diagrams and maps are common tools for communicating forestry information, but understanding is less guaranteed for those less accustomed to such representations. Reasonably realistic, close to real life representations have the greatest potential to demonstrate concepts in a compelling manner. In particular, showing land and land use based concerns in reasonably realistic landscape visualisations is most effective (Appleton & Lovett, 2002; Sheppard, 2005).

These 3D representations of landscapes, also known as 2.5D as they represent the land surface and are therefore not truly 3D, go beyond the two-dimensional representation of traditional maps. Analysis of the literature shows examples of 2.5D visualisations which relate to six of the Montréal Process indicators. However, significant work needs to be done to assess the potential of visualisations for the remainder of the indicators.

Landscape visualisations which represent actual places and on-the-ground conditions that people can readily identify with have been shown to have a higher effect than abstract settings (Sheppard, 2005). Photo-realism has been favourably compared to schematic representations, with gaming software contributing much to the development of realistic representations of trees and treed landscapes.

Immersive and interactive visualisations have been found helpful in understanding effects. (Salter, Campbell, Journeay, & Sheppard, 2009). Combining a number of visualisations or visualisation types has the benefit of compounding the effect on the power of understanding information. Animation can be used to involve the viewer's attention, while interactive visualisations help with exploration.

Visualisation technologies

Geographic information systems (GIS) are commonly used in forestry. This software, in contrast to images and games, manages land-based data such that the displays always represent the latest data collected. Typical GIS displays are two-dimensional maps. Communicating via a two-dimensional map is best suited to those with spatial ability, whether innate or learned, such as foresters and planners.

For some, even the provision of map-reading help and additional information does not alleviate their lack of ability to understand a two-dimensional representation. Increased 2.5D capability in GIS software, such as being developed by ESRI who are the lead producers of GIS used by forestry in New Zealand, is of interest for visualisations. Representation of the Ngati Whakaue study information in 2.5D provides an added dimension for the viewer.

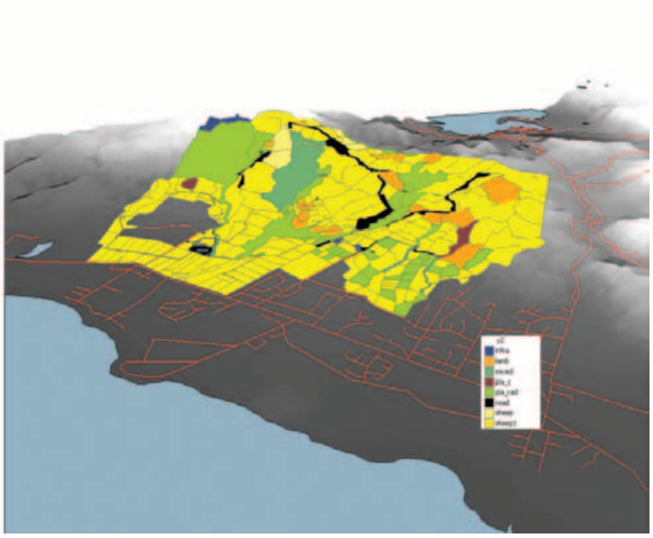
Published 2.5D forestry visualisations matched to the Montréal Process criteria and indicators

Criteria	Indicator	Papers
1 Conservation of biological diversity	1.1c Fragmentation of forests	Auclair, Barczi, Borne, & Etienne, 2000; Wissen, Schroth, Schmid, & Lange, 2005
2 Maintenance of productive capacity	2.a Area and percentage of forest land	Auclair et al., 2000; Dockerty, Lovett, Sunnenberg, Appleton, & Parry, 2005; Forestry Commission, 2005; Perrin, Beauvais, & Puppo, 2001; Wissen et al., 2005
	2.9 Annual harvest	Orland, Daniel, & Thorn, 1997; Williams, Ford, Bishop, Loiterton, & Hickey, 2007
3 Maintenance of health and vitality	3.2 Forest affected by biotic processes and agents	Sheppard & Picard, 2006
	3.b Forest affected by abiotic agents such as fire	Kaufman, Fornwalt, Huckaby, & Stoker, 2006; Zimmerman, Akerelrea, Kapler Smith, & O'Keefe, 2006
5 Maintenance of contribution to carbon cycles	5.a Total forest carbon pools and fluxes	Chertov, Komarov, Andrienko, Andrienko, & Gatalsky, 2002

A common alternate to GIS is specialist landscape visualisation software such as the Virtual Nature Studio. This software links to GIS, but requires learning new skills and additional software. The accessibility of aerial photography and satellite imagery in Google Earth, along with its ease of navigation, has made this an increasingly popular resource for location-based representations. For this approach to become more useful to environmentalists, Google developed 3D trees for different species, including a section of the Amazon forest.

Increasing experience

A New Zealand application example is the web explorer for forest ecosystem services where various spatial data layers can be interrogated on a Google Earth platform to show the effects of land use change. Being able to assess results for scenarios while looking at photographs of the land increases the reality of the experience for users.



2.5D view of the Wharenui block of Ngati Whakaue farms

One thread of new technology developments are immersive environments, such as the large wrap-around screen of the virtual reality theatre of the University of East Anglia, although these require dedicated hardware and specialist skills. Others are augmented reality options, such as the overlays of text on to the live image shown by a smartphone camera. The overlays are created based on the positioning and tilting information of the phone showing the visualisation in the field. These developments provide promising options for representing sustainability information for forestry.

Visualisation data

For locally accurate visualisations the need for high resolution data is a problem. This data has traditionally been expensive or difficult to obtain. Fortunately, it seems that recent trends in New Zealand for free access to national lower resolution data are now being replicated by councils who previously required their high resolution data to be purchased (Ferrel, 2012).

Nevertheless, decreasing costs of data capture technology, such as for LiDAR, makes large sets of data more common. This increases precision and detail, but also challenges our ability for analysis, and visualising them exploits the ease with which our eyes discern patterns and outliers.

Visual approaches developed for processing large amounts of data are known as information visualisation. They provide quick initial visual assessments of data. An example shows New Zealand census data of forestry employment for six census years and each district, where the more uneven a district's shape is, the more the employment levels have altered over a period of time.

Conclusion

Visualisations provide new opportunities for communication of sustainability information. The diversity of approaches allows us to address different levels of stakeholder expertise, styles of communication, and types of data more effectively. Future case studies will investigate a range of visualisation approaches across different types of sustainability indicators, with evaluations across different stakeholder groups.

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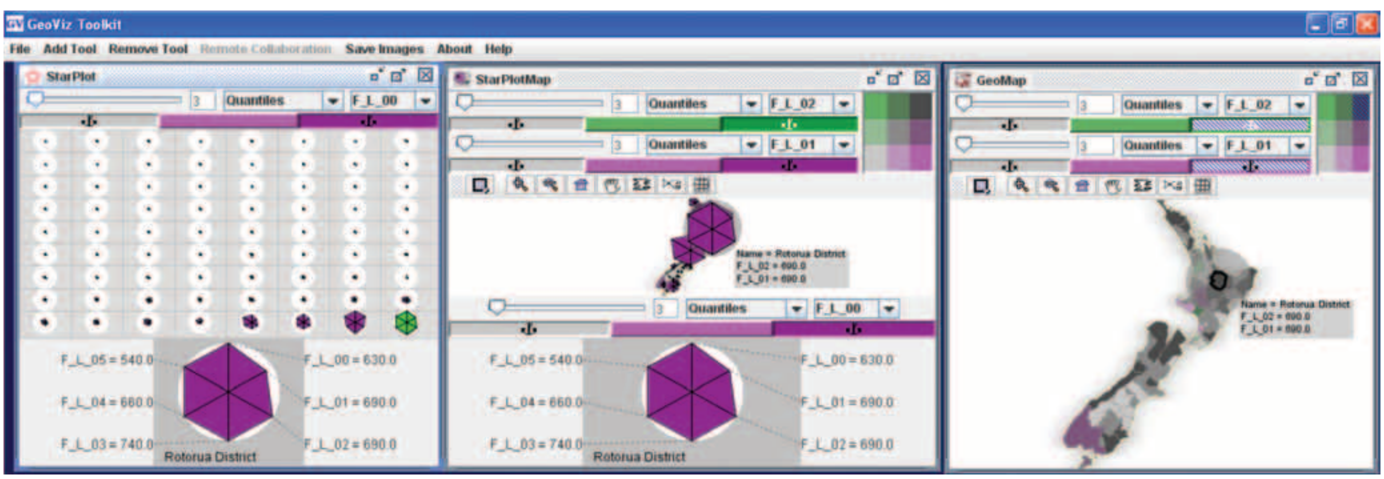

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For Table 1

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