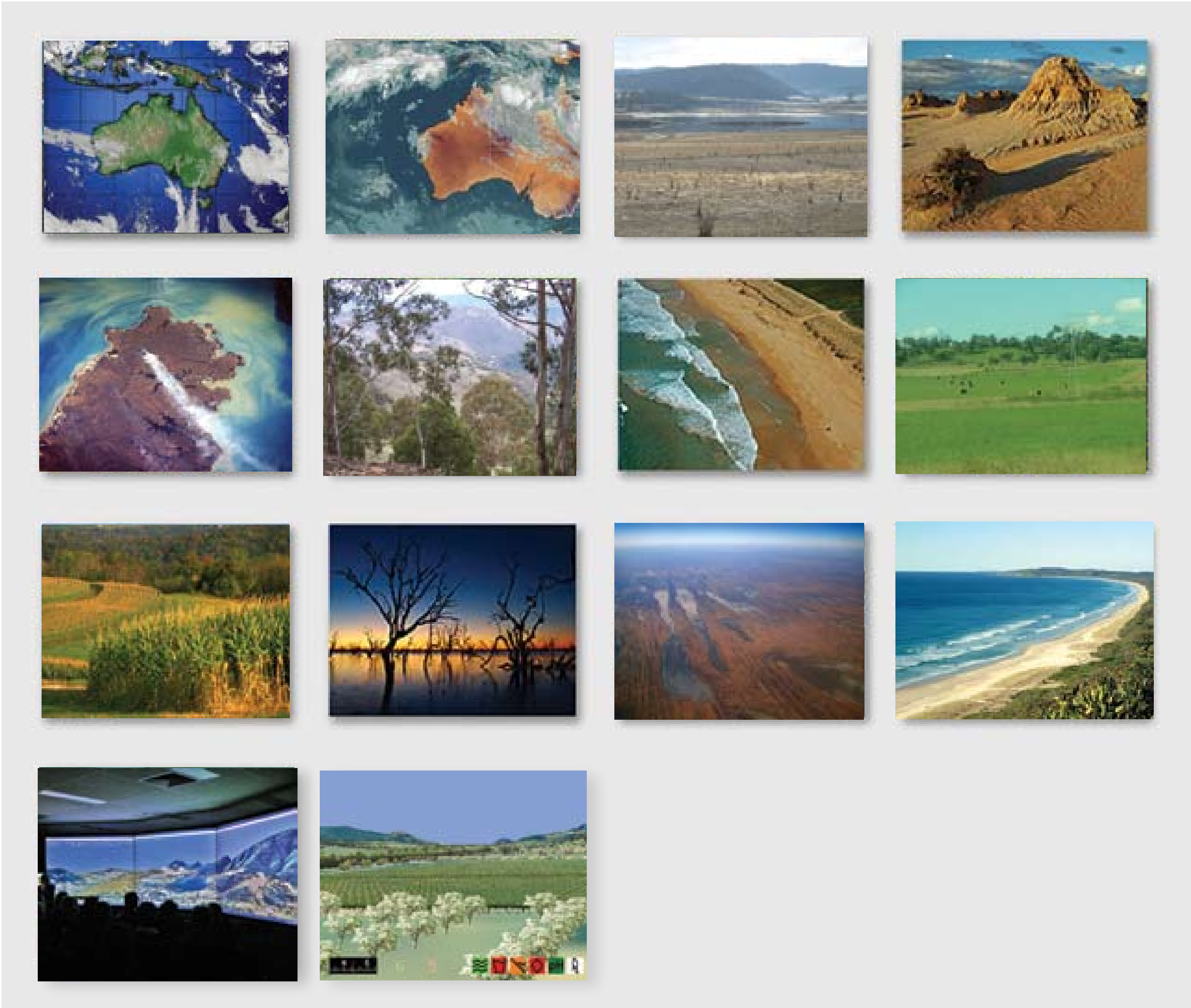

Collaborating in Virtual Environments

—by Christian Stock

Imagine a valley swept by drought caused by climate change and threatening the economic survival of the local township. Or, another valley which predominantly farms cattle pressured to adopt alternative economic land-use choices because of dropping beef prices caused by consumers frightened of Mad-Cow Disease. Or, a coastal harbour front which may face an increase in storm floods and oceanic sea level rises as a result of global warming. Or, fire fighters trapped in a burning indoor environment fighting for their lives. Each of these environments poses complex challenges to the individuals involved, and (sometimes quick) decisions have to be made to act upon those challenges.

Change is inevitable and individuals and communities are constantly facing decisions that revolve around change. They have to make plans on how to react to changes to be able to face the challenges that come with the changes. To make plans, advice from experts is usually sought.

However, when experts add complex facts and knowledge, non-experts need to be able to understand the experts' advice. Too much and too complex information can, sometimes, overwhelm the human brain—it avoids making decisions, which can have detrimental effects on individuals and communities.

It is well accepted that humans process visual information easier than other sensatory information. Presenting problems and facts in an easily accessible visual way can improve understanding significantly, making decision processes easier and faster. Ultimately, better solutions may be found that provide more long-term benefits.

The Spatial Information Exploration & Visualisation Environment (SIEVE) is a system that shows complex information from a real environment in an immersive 3D virtual environment. The end goal of

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this system is to present information in an engaging and accessible collaborative environment where end users can explore different scenarios, investigate various challenges, discuss the issues at hand, and then jointly form solutions.

SIEVE was developed by the Cooperative Research Centre of Spatial Information and the University of Melbourne. The main focus in the past four years has been on rural applications. This year, the focus has been widened to peri-urban environments and the security context which includes indoor environments.

One of the cornerstones of SIEVE is fully automatic environment generation from spatial data. Production of automatic environments can be very labour and resource intensive. Therefore we developed a solution which allows the building of generic environments using a set of algorithms and rules.

While the virtual environments are not looking exactly like their real counterparts, they still look reasonably similar by effective selection and distribution of vegetation species and the use of geotypical objects (farm houses and other rural structures). SIEVE works best with areas between 5 x 5 and 20 x 20 km^2.

End users can log onto a web page and select an area of interest from a map via easy-to-use map selection tools. The process is as simple as scrolling through a map, zooming to an area of about 10 x 10 km^2 and confirming the current view as the selection area. Once the end users are happy with their selection, they can press a button and trigger an automatic 3D landscape model-building process.

The building process generates a ground surface from a digital terrain model and aerial photography. To populate the environment, SIEVE can take point locations to place objects such as houses or trees and then take spatial vegetation classification data to build realistic vegetation distributions.

After the 3D model has been generated (this typically takes about 5 minutes), the end user will get an e-mail with a download link. After downloading the file (typi-

Virtual landscape built in SIEVE using vegetation data

cally less than 1 MB), the user can then view it on a local SIEVE installation.

SIEVE is built on Garagegames' Torque Game Engine and includes a host of features common to online 3D first-person video games. Users can walk around in a 3D environment that looks realistic and interact with each other over the Internet.

Modeling the effects of unmitigated global warming trends

Same view with land management to mitigate global warning

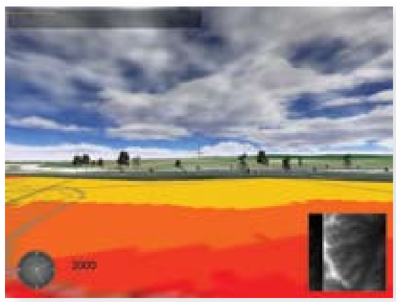
While generating the status-quo as a virtual environment is an interesting exercise, the real power of SIEVE is in generating hypothetical futures. One application area we are currently working on is in climate change and its effects on rural landscapes. SIEVE allows us to show the effects if no action is taken to mitigate global warming.

One scenario shows the resulting landscape drying up, crops will not grow as well and thin out, trees may die back, and livestock numbers will decrease. A second scenario shows a much healthier future, where more resilient crop species are introduced and land use is changed to more suitable species.

SIEVE is not just about the visual representation of landscape surfaces; it literally allows users to "dig deeper." For instance, it can be used to view underground layers to see the geology below ground or other important information such as water tables.

Explorations of the underground can uncover important dependencies between the surface and the subsurface, and understanding what they are helps farming, reforestation, and other human activities.

Farmers usually have a pretty good idea which parts of their farms are affected by soil salinity. By exploring the underground they can find areas that may be suitable for reforestation or tree plantations to decrease the groundwater level and therefore eliminate the surface salt. Scientific surface data (e.g., land capability) can be superimposed over the ground texture and is helpful in revealing other spatial dependencies.



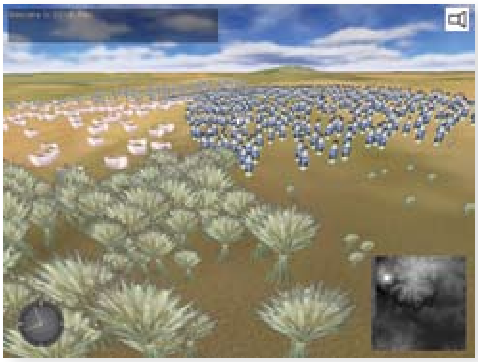
Examining what lies above and below the surface

But this is not the only option SIEVE users have for viewing surface data. SIEVE can show these data as icons of variable density and size.

A popular application of such iconic display is agricultural productivity. Farmers can explore how productivity spatially relates to their land and, more importantly, they can explore alternative future scenarios—such as, will there be decreased productivity if no action

is taken to reduce the effects of global warming, and will productivity increase be at least sustained if the land is managed well and appropriate changes are introduced.

Another application enables farmers to explore their present and future plans.



Iconic display of agricultural

This application links SIEVE directly to the eFarmer system, a 2D map application that was developed by the Victoria State Government and allows farmers in Victoria (Australia) to map their existing land use, develop future plans and track productivity.

The SIEVE-to-eFarmer direct link lets farmers see how their land visually changes as they change the land cover. Once farmers submit plans that may be implemented in the future, alternative scenarios of catchment areas could be visualized, together with the estimated productivity.

SIEVE also links to the Clever Cattle & Cropping Systems project run by the the Cooperative Research Center of Spatial Information and the University of New England. The scientific information generated by the project is intended to help farmers to identify important issues affecting the productivity of their land, such as at which level will fertilizer application be efficient. By using SIEVE in this way, farmers learn which of their production strategies will have effect on productivity.

But that's not all that SIEVE offers in terms of pre-generated scenarios. Once they have identified the likely scenaria, users can directly link to a GIS and manipulate data while the visualisation is running. They can manipulate land use in the GIS and immediately see the outcomes in 3D. Another possible use is animating growing forests or subsurface information, cycling through different tree population density scenarios, and viewing the effects on the subsurface water tables.

The GIS interface can also be used to query attributes of individual objects from the 3D. This can be used to gather attribute information directly from the 3D without the need to manually look up the GIS database. Another capability allows users to manipulate the 3D via an editor in SIEVE and update the GIS database from the 3D. Using this functionality, end users can build hypothetical scenarios in the 3D and save them to the GIS database.

SIEVE also has in-built functionality as an augmented reality system. Users can take the system into the field and view supplementary information (e.g., new plantations or underground data) via virtual reality goggles. The system is portable, so users can walk across the landscape, and the position of the virtual environment is updated via GPS and a head tracking device. Using the GIS live link, users can also update the existing GIS database, for example, by planting new trees in the augmented environment or correcting misplaced trees.

One advantage of SIEVE is that it allows users to collaborate over the Internet. Not only can users explore existing conditions and possible future scenarios, they can also discuss issues at hand and jointly develop strategies to deal with presented challenges.

Users can come from different backgrounds. Stakeholders, scientists, and policy developers can be collaborating at the same time, in the same space. Stakeholders can ask questions about environmental processes they don't have expert knowledge on which the scientists can answer. Scientists can demonstrate cause and effect or show process models. Farmers in turn can show scientists where their models may not work because they know about parameters that weren't included in the models (for example, a farmer may have planted new trees). Policy developers can learn what policies have had any effect and get a feel about levels of acceptance by stakeholders. Stakeholders may suggest their own policies once they better understand the causes and effects of their own actions.

Ongoing work is taking SIEVE into other application areas including the (peri-) urban and indoor environments. In the urban environment we're exploring sea-level rises due to global warming. Another urban application is the building of a multi-user simulation for simulating naval security threats to harbours. In these multi-user environments, multiple user groups have to make real-time decisions to counter changing threats. Also in the security context is another new application—using SIEVE to automatically build indoor environments from sketch

Taking SIEVE into the Augmented Space

plans. Once this functionality is achieved, the indoor models will enable multiple users to react to security threats in changing environments.

We see SIEVE as a platform that will change the way how spatial information is conveyed and understood. SIEVE will help to develop better strategies for dealing with impending change and hopefully lead to better future outcomes.

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