1st Moorea IDEA Workshop - ETH Zurich, November 2013

Location
The Platform for Advanced Scientific Computing and the Pauli Center for Theoretical Studies at ETH Zurich, Switzerland

Conveners
Neil Davies (UC Berkeley)
Dawn Field (Oxford)
Matthias Troyer (ETH)
Serge Planes (CNRS-EPHE)
Sally Holbrook (UC Santa Barbara).

Sponsors
Pauli Center for Theoretical Studies
Platform for Advanced Scientific Computing (PASC)
U.S. National Science Foundation (OCE 12-36905).

Theme
Grand Challenge - Human activities are driving climate change and biodiversity loss on a planetary scale. Resulting impacts on the Earth System are so great they define a new geological epoch: the anthropocene. With the human population expanding beyond 7 billion in the 21st century, global environmental sustainability is the defining challenge of our time. The transition to sustainable development, however, requires a far better understanding of complex socio-ecological systems at local and national scales of management action. To that end, a key research goal is to build functioning digital simulations, 'avatars', of model islands, cities, and eventually countries. Such advances will pave the way for a Predictive, Preventive, Personalized, Participatory, and ultimately a Planetary (P5) approach to policy making for sustainability. The outcome: communities and countries managing their ecosystem wellness and avoiding the social consequences of ecological collapse.

The Island Digital Ecosystem Avatars (IDEA) Project is inspired by efforts to digitize an entire island ecosystem from 'genes to satellites' and was initiated by researchers at UC Berkeley, CNRS-EPHE, ETH Zürich, and Oxford University. It will draw on the significant progress being made to model complex systems at other scales of biological organization - from single cells to multicellular organisms, including humans. The IDEA Project will harness and extend these efforts to build advanced computational models of a range of complex socio-ecological systems, particularly islands (coupled natural-human systems)

and cities (built environment).

Welcome Letter

Dear Moorea Avatar Workshop Participants,

We look forward to seeing everyone in Zurich Nov 18-20. Details of the meetings are being posted on the <u>ETH</u> <u>Avatar</u> <u>website</u>, which also provides background to the project and Moorea. This [Google](#) [Doc](#) will be open to all participants to post comments so we can develop our ideas, in particular the main products (see below).

In brief, the workshop will bring together about 35 people who either work on Moorea already or have relevant expertise from other systems. Participants include experts on coral reef ecology and oceanography, computational physics, general ecosystem models, complex systems, microbial ecology, bioinformatics/informatics, biodiversity genomics, environmental design, systems biology, human ecology, weather prediction, and climate modeling.

We have worked up an agenda that is designed to be flexible and informal but to cover most of the major topics. We need some presentations to get everyone on the same page, so we have 'volunteered' some of you to say a few words (and suggested a title) and/or to chair a session. Let us know if you would like to make any changes. Most presentations are in panel format to ensure maximum opportunity for interaction. We then have quite a lot of time in breakout groups and working sessions. If anyone has any suggestions for the program, we are very happy to discuss and incorporate your ideas.

The workshop provides a great opportunity for this emerging community to meet for the first time and explore linkages between existing projects and to forge new ones. Thanks for agreeing to participate!

Best wishes,
The organizing committee - Troyer, Davies, Planes, Field, Holbrook

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Pre-meeting Preparation
Please think about the following:

- Potential participants in the Moorea Avatar project
- List of datasets/models and questions already being addressed by this community
- Wish list of datasets/models for the future
- Vision of what the Avatar should do and what questions it should help address/which problems it should help solve

Also consider this as a thought experiment: XPrize is currently seeking ideas for new [Ocean](#) [XPrizes](#). What would you want for a Moorea Avatar XPrize? What can we predict? Why would

anyone care? How can we validate/test progress each year?

Agenda

Last updated Nov 10, 2013

Sunday 17 November 2013
Arrival

Monday 18 November 2013
Location: HIT E51

9:00 - 10:30 Introduction to Moorea
Chair: Dawn Field (Oxford)
09:00 Welcome and Goals - Matthias Troyer (ETH)
09:10 From Moorea Biocode to Avatar - Neil Davies (UC Berkeley)
09:30 CRIOBE (CNRS-EPHE) Research on Moorea - Véronique Berteaux (CNRS-CRIOBE)
09:50 The Moorea Coral Reef LTER - Sally Holbrook (UC Santa Barbara)
10:10 Introductions by all Participants

10:30 - 11:00 Coffee

11:00 - 12:00: Singapore Future Cities Laboratory
Chair - Matthias Troyer (ETH)
11:00 The Future Cities Laboratory - Reinhard König and Armin Gruen (ETH)

12:00 Lunch

14:00 - 15:30 Panel Discussion 1: Multiscalar Ecological Modeling
Chair: Rich Williams (PEaCE Lab)
14:00 Introduction from Chair
14:10 Flash Talks (5-10mins) by panelists:
1. Genetic Networks and Systems Biology - Sauer (ETH)
2. Ecosystem Modeling - Cherie Briggs (UC Santa Barbara)
3. Coupled Natural Human Systems: Model Islands - Neo Martinez (Univ. Arizona)
4. General Ecosystem Models - Mike Harfoot (Microsoft Research/UNEP-WCMS)

15:00 Discussion

15:30 Coffee

16:00 - 17:30 Physical Moorea (Part 1)

Chair: Jim Hench (Duke)

16:00 Introduction by chair

16:00 3D/4D modeling of landscapes and cities - Armin Gruen (ETH Zurich)

16:10 Towards a 3D Map of Moorea - Slava Turyshev (Caltech NASA; UCLA)

16:20 Ocean Biogeochemical Dynamics - Nicolas Gruber (ETH Zurich)

16:50 Discussion

17:10 Review meeting goals and plan for next day

17:30 Close

Tuesday 19 November 2013

Location: HIL E4 (morning) and HIL E7 (afternoon)

09:00 - 10:20 Panel Discussion 2: Invisible Moorea

Chair: Veronique Berteaux (CNRS-CRIOBE)

09:00 Introduction from Chair

09:10 Flash Talks (5-10mins) by panelists:

1. Measuring Biodiversity - Chris Meyer (Smithsonian)
2. Censusing Microbes - Linda Amaral-Zettler (MBL Woods Hole)
3. Host-associated microbial diversity - Ruth Gates (Univ. Hawaii)
4. Microbial influences on ecosystem function - Craig Carlson (UC Santa Barbara)

10:00 Discussion

10:20 Plan for Breakout Groups - Neil Davies (UC Berkeley)

10:30 - 11:00 Coffee

11:00 - 12:00 Education and Society Session

Chair: George Roderick (UC Berkeley)

11:00 Linking Biodiversity, Ecosystem and Society - Joachim Claudet (CNRS-EPHE CRIOBE)

11:20 Discussion

11:50 Instructions for Breakout Groups - Matthias Troyer (ETH)

12:00 - 14:00 Breakout Sessions (meet over lunch)

12:00 Lunch

14:00 - 14:30 Working Session
Chair: Hans Herrmann (ETH)
- Breakout groups report back
- Refine groups and/or continue

14:30 - 16:00 Breakout Sessions

15:30 Coffee

16:00 - 17:30 Physical Moorea (Part 2)
Chair: Neil Davies (UC Berkeley)
16:00 Weather and Climate in French Polynesia - Marania Hopuare (METEO France; UPF)
16:10 Simulations of weather and climate in mountains and islands - Christoph Schär (ETH)
16:30 Discussion

17:00 Plan for next day
17:30 Close

19:00 - 22:00 Conference Dinner in Restaurant Grünes Glas

Wednesday 20 November 2013
Location: HIT E51 and breakout rooms

09:00 - 10:00 Chair: George Roderick (UC Berkeley)
09:00 Introduction by Chair
09:10 Teaching Complex Dynamical Systems - Courtney Sale Ross (Ross Institute)
09:30 Biocode Outreach: biocubes as an educational tool - Chris Meyer (Smithsonian)

10:00 - 10:30 Synthesis Session

10:30 Coffee

11:00 - 12:00 Synthesis Session
Chair: Russell Schmitt (UC Santa Barbara)

12:00 Lunch

13:30 - 15:00 Action Plan
Chair: Matthias Troyer (ETH)

15:00 End of meeting

Products

Papers

1. *Time to Model All Life on an Island: the Moorea IDEA'* co-authored by participants including some of those who cannot make it to Zurich
2. *Towards the best characterized model ecosystem: the island of Moorea* - a review paper on Moorea that outlines the Moorea IDEA Project for potential funders

The first is a general justification for the IDEA explaining why we think it is important to concentrate on model ecosystems. We would aim to publish this in a major journal. The second paper should also be published eventually. It would describe what we know about the Moorea system already and how specifically we would advance Moorea as a proof of concept for the Avatar. The first phase of this would be a white paper that will also serve as the basis for potential funding proposal/s.

Road-Map
Draft plan for subsequent Moorea Avatar workshops:
- Oxford 2-4 April 2014
  - The Moorea Interactome and Integrating Biodiversity Genomics into General Ecosystem Models
- University of California
  - The built environment, food, energy, and water security

- Moorea Ecostation
    - Civil society and government engagement in sustainability planning

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Meeting Notes

Please think about the following:

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- Vision of what the Avatar should do and what questions it should help address/which problems it should help solve

Also consider this as a thought experiment: XPrize is currently seeking ideas for new Ocean XPrizes. What would you want for a Moorea Avatar XPrize? What can we predict? Why would anyone care? How can we validate/test progress each year?

We have to address 3 main criticisms about focusing on an island as a model system:
1) A whole island is too big complex
2) An island is too small local, should do something larger scale (global)
3) OK, I get it, an island is good, but why Moorea and not …

Breakout 1 - Physical (notes)
Location HIT building G31.1

What is the big picture? Why build the avatar? What is the pitch to funding agencies? What are the offshoots of the model? Gain a better understanding of the dynamic evolution of an ecosystem, using models and observations spanning the physical, biological, economic and social words. The project provides a platform for addressing questions on economic and ecological sustainability on a common platform.

What can we provide as inputs to the ecological modeling?
    often less accuracy needed in the biological applications than is aimed for in the physical sciences

It should not only provide services but be of interest to the individual disciplines. What is the scientific question for the physical disciplines themselves?
    weather: ocean/atmospheric coupling

oceanography: going from global to local scales
shallow water flow: …

What is an island? what is the simplest model that is recognizable as an island? What are global features, what is island specific?

Flow of nutrients from land to lagoon is missing - we need people to model this
We need to define subsystems, and prioritize

Breakout 2 - Ecological Modelling (notes)
Location HIT building K51

Overarching Grand Challenge = What is the future of the socio-ecological world on Moorea under different scenarios?

We need to answer this for the planet (IPBES) and for all local communities (socio-ecological systems) but such a complex challenge must first be solved in a small number of model systems

(Policy relevant but not policy perspective)

Modelling Group's Goal = To develop a forecasting tool that predicts key aspects of the future socio-ecosystem of Moorea under different scenarios

This will require input from invisible group to describe interactions and physical group on processes

- What would that tool (toolbox) look like?
    - It will have to capture feedbacks between social and ecological systems
    - Coefficients have to be biologically plausible and testable in the field
    - Moorea is a nested hierarchy of systems - it can be divided into voxls for high resolution up to the largest voxl which is the island. Fine scale models enable high resolution validation, and then simplified for next scale out.
    - Enables exploration of sensitivity in the parameter space and helps direct fieldwork on Moorea
    - Demonstrates where global projections breakdown (or not) locally in a particular system (Moorea)
    - Must include organisms (species) interactions

- What are the key socio-ecological aspects we need to predict? (Are some of those unpredictable?)
    - Whether the reef is coral or algal dominated

Location HIT building K52

discussion points raised by the group:
- like idea of looking an increasing population on Moorea and need for sustainability - what is the carrying capacity in this finite space (a natural lab)(Veronique)
- the socio-ecosystem model of Moorea presented by CRIOBE is a great starting point (Dawn, Veronique)
- will humans or climate have more of an impact in time? (don't forget climate change!)(Ruth, Sally) - this is the experiment that is being done - what will time tell? the big storms are doing the most damage - Ruth/Sally/Veronique)
- Invisible life could provide an early warning system for drivers of interest (Chris, All)
  - indicators: sensors (oxygen and eutrophication), pathogens, caffeine, synthetic estrogens (human impact), statin
- sampling - do we have enough data (All)
  - even in a stable system, like Moorea, (Craig) sampling one day to the next can be different, wholesale shifts could be detected, do see seasonality patterns
  - (Chris) macro orgs more stable (temporal persistence)
- Taxonomy versus function (Ruth) - we don't understand functional groups yet (Ruth)
- Define optimal functioning for Moorea - how do we get there or keep state (acceptable variation) - even if we can predict, could we ever change? (Ruth)

STARTED TO DISCUSS THE QUESTIONS - PRE-AMBLE

General ideas

Why Moorea: Who is most influential end member at each level of diversity - for the island it is us (humans) and weather - link - carrying capacity, end members, find at each level of scale - (Ruth)

What we want to predict
Irreversible changes to ecosystems and tipping points (algal and slimy reefs, loss of ecosystem services) (Hawaii is sewage - the main threat to reef - Ruth)

Defining Status of Invisible World component on Moorea:

Existing data tells us (bac, arch, eu microbial life - all three domains, including young larger things with DNA barcoding):
We are still data poor -

We are still missing 60% in biocode invisible world studies

Where are the plateaus? we don't have them yet

70% dark taxa for bacteria

there are seasonal variation, depth difference, inshore, offshore - drivers tagged to chemistry (physical world) (biotic as well)

NEED TO DISCUSS - HOW MUCH DATA/WHAT DATA WOULD WE WANT - SPECIFIC QUESTION

how much functional diversity is there?

We have to address 3 main criticisms about focusing on an island as a model system:
1)   A whole island is too big complex
2)   An island is too small local, should do something larger scale (global)
3)   OK, I get it, an island is good, but why Moorea and not …

we have more data than anywhere else - and across multiple scales (biocode + microbial)

history

people/tourism

discreet