Summary of GLEON 4 Meeting
2 – 5 March 2007
Lammi Biological Station, Finland
v14March07
revised 28 March 2007
Finalized 6 June 2007

Attendance: This Fourth GLEON Workshop was attended by 31+ individuals, representing at least nine lake groups around the world, as well as many limnological and cyberinfrastructure research groups.

Sponsors: The support for the meeting came from several sources:

- Lammi Biological Station
- Gordon and Betty Moore Foundation
- National Science Foundation, in particular the Nordic Supplement to the "Autoscaling" award (DBI 0446017 – Autoscaling award; Supplement DBI-0635325)
- Häme Development Centre and also from the City of Hämeenlinna
- Individual participants' home institutions or funding agencies

Next Workshop:

- The next Workshop will take place on the day before SIL, on Saturday 11 August 2007 in Montreal.

Homework from this Workshop:

Potential Science Working Groups (see below for list of working groups): We are asking each group to

- Create a plan (with two or three next steps) for leveraging GLEON sites, and identify data to collect (possibly existing already, or experiments to conduct), potential sites to be involved, and students who would be interested in the research (for part of their thesis work).
- Implement step one of their plan
- Present the plan at the pre-SIL meeting on 11 August 2007
- Suggest other individuals who might have interest in GLEON, e.g. Bruce Hargrave of Lehigh.

Controlled Vocabulary and Web Site (Barbara Benson)**:**

- Controlled vocabulary:
    - The list of variables directly measured by sensors at GLEON sites was reviewed.
    - Further development of the GLEON Lake Information Database that will allow capture and website display of sensors used at each site to measure these variables was discussed, and feedback was given on the prototype data entry web form.

    - Discussion took place on the attributes of an observation. Here is the working list:
        - Measurement type
        - Unit
        - Location
            - GPS and geographic description (lake name)
            - Z coordinate (depth or height)
        - Timestamp
        - Temporal resolution
        - Method (sensor type)
        - Data quality
        - Contributor
        - Access restrictions

- Web site:
    - Continue to enhance features of site (e.g. images)
    - Encourage other sites to add data
    - Create query functionality for the information in the GLEON Lake Information Database (e.g., What sites are measuring variable X? Who is the expert contact at each of these sites? List the sensors used to measure X at each site?)

Lake Sunapee Roll out (Kathie Weathers, Ken Chiu)**:**

- Have buoy in lake
- Implement a version of web interface to data

Lake Erken (after the meeting) (Thorsten Blenckner, Don Pierson, Tim Kratz, Paul Hanson)

- Create SWAT team to implement sensor system in Lake Erken (streaming data from sensor into database)

Governance (aspects to be presented before and no later than the SIL meeting 11 August 2007)**:**

- Mission Statement for GLEON:
    - Request input based on discussion from all members present (see below).
    - Have a group of volunteers create a mission statement based on input
    - Circulate prior to SIL
    - A committee for circulating and generating ideas for the Mission statement include the following individuals:
        - Cayelan Carey
        - Evelyn Gaiser

        - Susan Hendricks
        - Trina McMahon
        - Kathie Weathers
        - David Livingstone
        - Kevin Rose
        - Peter Arzberger
    - This committee will work with the GLEON Steering Committee
- Towards a GLEON Governance Framework:
    - The participants of the meeting identified several issues that needed to be addressed (listed below). The plan, before SIL, is to draft positions on these issues, via a committee yet to be constituted. At SIL these position would be presented. Peter Arzberger will co-chair this committee.
    - Membership
        - Create draft criteria for membership, anticipating the question: How does one become a member? In this consideration are issues of members' responsibilities and benefits.
    - Steering Committee
        - Draft a set of responsibilities of a steering committee
        - Identify key people to be involved
    - Relationship with RCN
        - Continue to work on the relationship between RCN the project and GLEON the organization.

DISCUSSION

Scientific Working Groups

Dissolved Oxygen Dynamics (Tim Kratz, Bom Chul Kim, Laurence Choi, … Paul Hanson, Don Pierson, … others)

- Inferring processes from high-frequency DO (with other ancillary variables)
    - Photo-adaptation
    - Calculating daytime respiration using C14 and DO
    - Lake metabolism
- Understanding relative roles of biotic vs abiotic controls on DO dynamics
- Modeling diel DO dynamics (midnight surge, metabolic signal)
- Understanding ecological influence of extreme DO conditions (both high and low)

Add summary of the work of Laurence Choi, in particular next steps.

Dissolved Organic Carbon (Craig Williamson, Ami Nishri, Evelyn Gaiser, Susan Hendricks, Kevin Rose – Note: there are other interested parties who were not part of this working group, including: Bomchul Kim and Paul Hanson):

Interests of investigators in group:
Ami - How DOC influences nutrient supply?
Evelyn – ENSO events that alter DOC and influence Lake Annie color, lake metabolism. Interested in looking at legacy of these events and impact on phytoplankton, nutrient versus light limitation and implications for phytoplankton community structure. Monitor depth of penetration of PAR Link this to heterogeneity of oxygen profiles – for example metalimnetic maxima.
Susan – Kentucky reservoir (182 miles long) heavily influenced by terrestrial changes, also interested in long-term change. What is cause of seasonal clear-water phase?
Craig & Kevin – DOC dynamics in response to climate change and effects on UV and PAR transparency, use of UV:PAR ratios to develop optical indices of DOC quantity and quality.

DOC questions for GLEON:
(1) How are C sources changing in different parts of the world?
(2) How does lake metabolism respond to different C sources?

For both (1) and (2):
- allochthonous vs. autochthonous
- primary productivity versus DOC
- mixing depth
- oxygen profiles
- transparency (PAR limitation and UV:PAR as diagnostic)
- DOC-specific absorbance?
- influence of pH (sulfate deposition and environmental controls)?
- Headwater Lake Annie versus flow-through Kentucky Lake, and alpine lake?

Microbes (Trina McMahon, Stuart Jones, Cayelen Carey, Stefan Bertilsson, Sally Holbrook)

"What are the major drivers of microbial community diversity, composition, and dynamics in lakes of different types, sizes, and in different locations?"

- What sampling frequency is sufficient to perceive these drivers?
- Disturbance as a proximate driver (though eventually we need to identify the ultimate)
- Relate these to high-frequency phys/chem data from buoys
- Assess food-webs/communities/populations
- Federation of laboratories that would collect and distribute (share) samples so that each principle investigator can look at his or her own pet variables (e.g. community fingerprinting, individual populations or taxonomic groups).
- Period of high-frequency sampling with agreed upon protocols and strategy for distributing samples (need to build consensus on this without creating unreasonable burdens for individual labs/researchers)

Trina and Stefan are organizing (along with Eva Lindstrom of Uppsala Univ) a workshop at SIL on the future of freshwater microbial ecology research. We will use this forum as another way to proselytize and recruit GLEON members, and to start to establish a coordinated global sampling effort. We also have the opportunity to use the workshop to formulate a proposal outline or white paper on how microbial ecologists could make use of these high-resolution datasets.

We should work toward improving/buliding sensors so that we move toward "lab-on-a-chip" technology. The Autonomous Microbial Genosensor is a great start, but it could be greatly improved from the perspective of scalability, cost, durability, power requirements, etc. We should partner with microfluidics specialists and process engineers to work on this.

Sally encouraged us to model our efforts after those of the marine microbial ecology community. Marine microbial ecologists have linked well with BATS and other long-term high resolution monitoring efforts.

Temperature and mixing in different climate regimes (David Livingstone, Glen George, Marko Jarvinen, Thorsten Blenckner))

Four specific scientific issues were identified, all of which should be viewed within the context of climate change, the primary impact of which will be on physical lake dynamics. This is important because physical lake dynamics is the ultimate internal driver of most lake processes. Because climate change will affect different climatic regimes (with their various lake types) differently, a positive effort needs to be made to expand GLEON in the direction of the under-represented tropics.

1) Climate forcing
Because of the initially limited duration of the time-series that can be expected to arise from GLEON, the long-term effects of climate change on lake ecosystems cannot be investigated directly. However, within a few years, in a range of different lake types and in a variety of climate regimes, it should be possible to study the effects of interannual variations in meteorological driving variables on physical lake dynamics, resulting in increased understanding of the mechanisms by which lakes in different climate regimes are driven by weather (i.e., small-scale meteorology) and climate (i.e., spatially coherent large-scale meteorology). This is a prerequisite to understanding the likely impact of climate change on lake ecosystems. Thus, for instance, the physical responses of lakes to unusually warm winters or summers that may occur during the first few years of GLEON can be compared and contrasted in great temporal detail with the lakes' responses to "normal" or colder winters or summers. The occurrence of extremely warm periods corresponding to the average conditions that are predicted by RCMs to occur, say, at the end of the current century cannot of course be guaranteed during the first few years of the project, but the likelihood of these occurring will increase with time.

2) Ice-on and ice-off
In high-latitude and high-altitude lakes, ice cover - and especially the timing of ice-off - is the most important physical determinant of lake ecology, governing, for instance, internal nutrient recycling and the timing of the spring algal bloom. As a result of climate change, there is already a detectable long-term global tendency for ice-on to occur later, and ice-off to occur earlier. Intensive measuring under ice, and especially during ice-on and ice-off, again coupled with high-resolution meteorological measurements, would allow the physical processes governing ice phenology to be studied in detail.

3) Internal nutrient recycling
The high-resolution GLEON measurements can be employed to plan field campaigns - at much lower resolution - to study the internal recycling of nutrients in a range of different lakes. These field campaigns would be triggered by knowledge of the timing of large-scale vertical mixing obtained on-line from the GLEON sites, and would complement the high-resolution measurements.

4) Phytoplankton diversity
The high-resolution GLEON measurements would allow us to investigate the influence of short-term mixing processes on phytoplankton diversity; i.e., to determine whether short-term physical variability results in a higher degree of phytoplankton diversity than that predicted by the competitive exclusion theory (Hutchinson's "paradox of the plankton"). This study should involve a whole spectrum of lakes from northern ice-covered lakes through temperate lakes to sub-tropical and tropical lakes, thus making use of GLEON's global dimension.

Cyberinfrastructure (Peter Arzberger, Barbara Benson, Ken Chiu, Hsiu-Mei Chou, Fang-Pang Lin, Sameer Tilak, Whey-Fone Tsai, Luke Winslow)

The goal of this group is to create an environment to do integrative science.

Early discussions included

- Communication between sensor and network, via tools such as data turbine.
    - We are in the process of setting up a parallel system for lake sensors in Madison using this new technology
    - We had preliminary discussion with NCHC to try this to stream video data (from coral reefs)
- Options to choose from (by July)
    - Take communication and “package” for others
    - OR, enhance communication with automating addition of sensors (for use of management of sensors and systems – good for sites)
    - We are leaning toward the latter option

During Breakout, we articulated several challenges:

- Discovery
    - Common, shared metadata
- Data access
    - Web accessible

    - Query-able systems
- Integrate data
    - Translation of different schema
    - Global schema
- Get critical mass of sites "on line"
- Create tools for others to use
    - Create ways to export databases to others

We also indicated several Challenges

- Common / global
    - Metadata schema
    - Schema
- Overall architecture
- Joint development (different funding)
    - This is important for distributed development
    - No one site has all of the funds

Mission Statement

At the GLEON 4 Workshop, there was a session on creating a mission statement for GLEON. One of the homework assignments was to invite input on mission statements from the GLEON community.

Attached below are the materials from two slides

- Draft statements created before the meeting
- Key concepts to be included in a mission statement at the meeting.

If you wish to suggest a statement, please send me your responses by **Saturday 10 March 2007 to Marilyn Larsen, mlarsen2@wisc.edu**

Draft GLEON Mission Statements PRIOR to the Discussion

- Build a scalable, persistent network of lake ecology observatories
- Understand key limnological processes such as the effects of climate and landuse change on lake function, the role of episodic events such as typhoons in resetting lake dynamics, and carbon cycling within lakes
- Gain understanding of role of lakes in large (global, continental) socio-environmental processes
- Build community of researchers to understand role of lakes in socio-environmental processes
- GLEON aims to understand and predict response of lake ecosystems to natural processes and human activities at regional, continental, and global scales.

  - Add "through information technology and in situ sensing" (bringing together IT and Lake scientists)

Some comments from Discussion on 3 March, for consideration

- Add aspect of "capacity building / human development / training / graduate students / next generation / education
- Add services to society / humanity
- Consider addition (or leaving opening to) groundwater, rivers, streams.

Key concepts to be reflected in GLEON Mission

- Lakes or more – (allow open to other activities in the future)
  - Comment: Lakes and reservoirs; rivers/ streams / groundwater / terrestrial
  - Lake ecosystem
- IT/CI / Database / Data resource
- Scientific Understanding …
- Network/federation / collaboratory
- Training (students / outreach)
- Link
- Social Utility / Relevance
- International ..
- Ecological
- Long-term, high-frequency observation
- Community
- Persistence
- Multiple scales: local to global (lake and catchment, lake and atmosphere)
- Automatic
- Sensors
- In situ
- (Role and response) / Sentinel
- Future conduct of research
- Insight / foresight
- What we will measure or tackle: e.g. Lake metabolism, global change

Other Issues:

Data sharing: Regulations and practices in different countries:

People volunteering to help with Mission Statement (let Marilyn Larsen know, mlarsen2@wisc.edu)

- Trina McMahon
- Susan Hendricks
- Cayelan Carey
- Others ???

Relationship between GLEON and the RCN (and perhaps other projects)

- The following table compares the roles of GLEON and RCN. Note that roles are not always exclusive but often overlap. This list could probably be expanded.

Feature	GLEON	RCN
Duration	Long term (> 5yr)	Moderate term (= 5yr)
Extent	Explicitly Global	Funding US, engages international participants
Funding	Multiple sources; helps sites obtain funding	NSF; helps grow student participation through alternate funding; spawns proposals
Networking	Focuses on building networks of organizations, people, and technology	Uses network and expands activities
Technology	Generates new technologies; liaison with other technology-generating programs; aides field programs in technology implementation	Bridges the gap between technology and ecology experts; emphasis on how technology enables the science and how the science informs the technology development
Research	Conducts experiments comparative analyses	Articulates the science that could be done with a network
Students	Student involvement emerging	Student involvement extensive

- [Added 6 June 2007] As GLEON develops, opportunities arise for specific projects that forward GLEON's goals and may attract external funding. The RCN is a 5-year, NSF- funded activity of GLEON that promotes the strategic development of GLEON. The RCN Steering Committee directs the management of this activity and engages others as invited participants