

Design and implementation of internet-based “Public Participation GIS” using a user-centred process and the open source model

Martin J. Bunch

***Faculty of Environmental Studies
York University
Toronto Ontario Canada***

Mike Maclennan

***Malone, Given & Parsons Ltd.
Markham Ontario Canada***

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Presentation Outline

- The Context of the monitoring program
- web-GIS
- Public Participation GIS (PPGIS)
- Redeveloping the web-GIS
 - Methods
 - Results
- Conclusions

The Context



- Urban and periurban
- Earlier Cut backs in monitoring
- Now:
 - Source water protection
 - Green belt
 - Oak Ridges Moraine development freeze

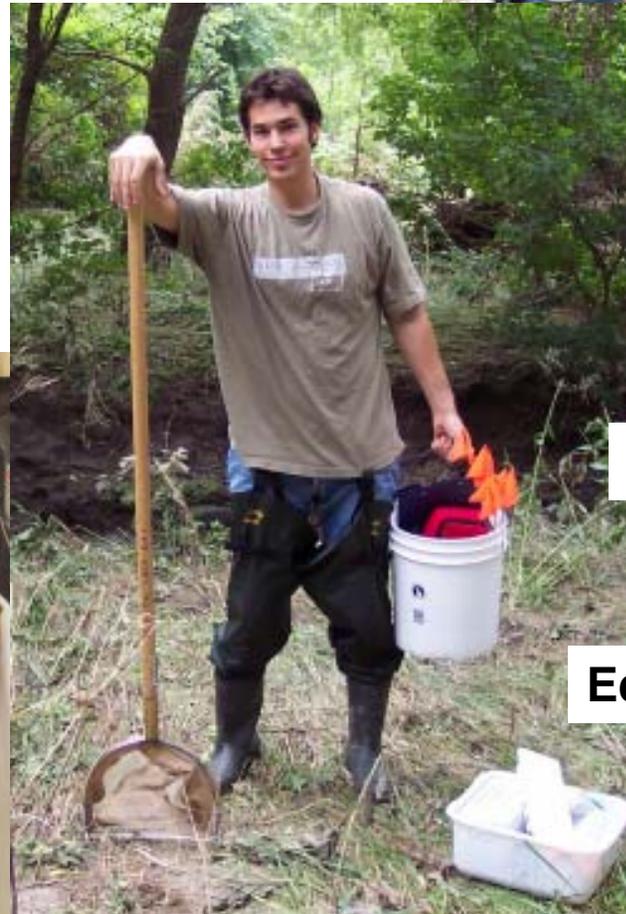
Image Source: www.toronto.ca/ourcity/location01.htm

A two-tiered monitoring program

- TRCA's Regional Water Monitoring Program
- Community-based Water Monitoring Program



Collecting the sample



Equipped to monitor

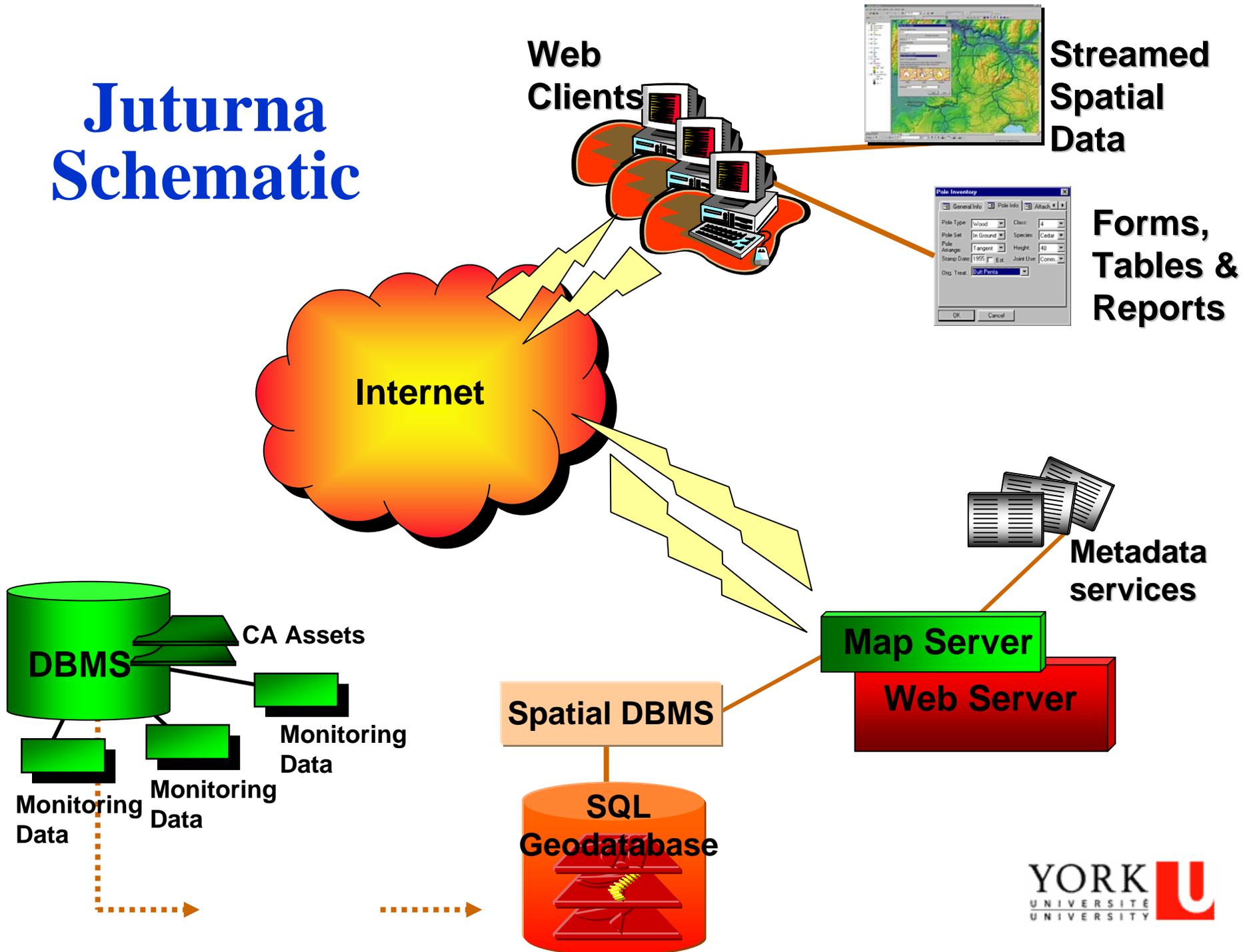


← Slowly going blind “bug picking”

What is “Juturna”?

- Web-based GIS application that supports environmental monitoring program in the Toronto region by
 - Facilitating collection and consolidation of water quality data
 - Providing tools for analysis of water quality data
 - Disseminating information on water quality within TRCA’s jurisdiction

Juturna Schematic



Upload Data - Select / Create a Sampling Site .

Map Func

- Zoom In
- Zoom O
- Full Ext
- Pan
- Select P
- Create
- Legend

Learn m about Map F

- PUE
- AQL
- TRC
- MAI
- WAT

Benthic Invertebrates

Benthos Collection Method: Kick and Sweep

Acarina (Water Mite): 0

Amphipoda (Scud): 0

Anisoptera (Dragonfly): 0

0

0

0

0

0

Measure: Biological

Aggregate Result: Potentially Impaired

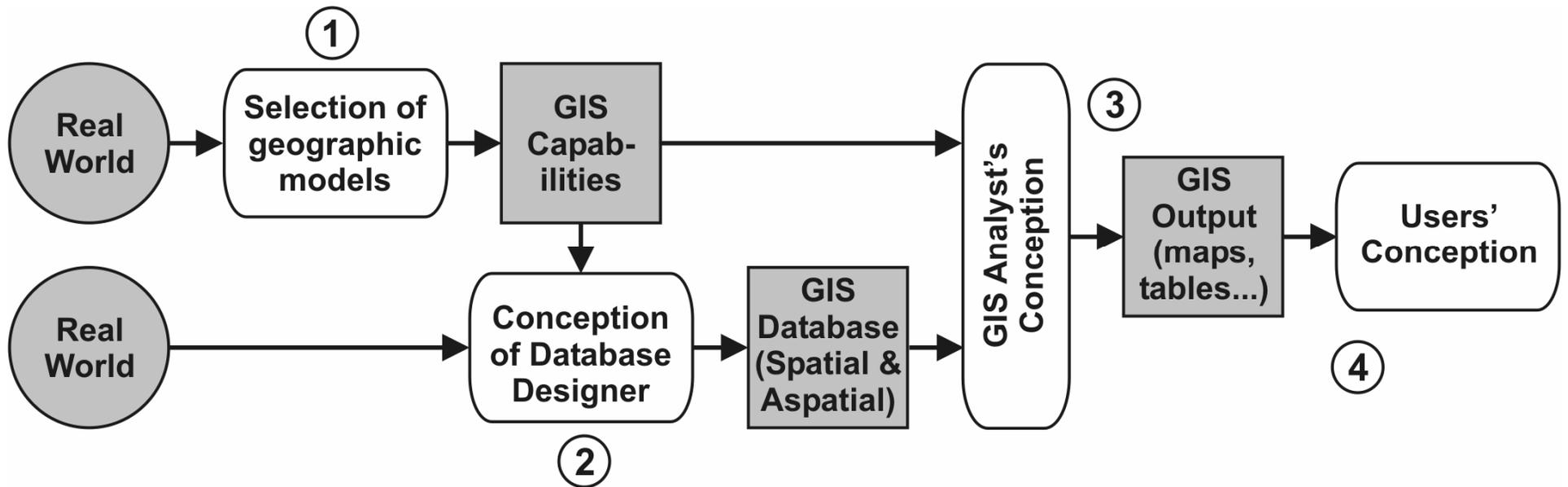
Collection Method: To provide a more robust measurement of stream health, an overall aggregate assessment can be used where all ten indices are considered together. There are two possible results for the aggregate result: unimpaired and potentially impaired. The indicator bar represents

Benthos	Value	Range
1. Macro	2%	2%
2. Macro	3%	3%
3. Macro	4%	4%
4. Number of Taxa	1	1
5. Total	5%	5%
6. Dominant Taxa	4%	4%
7. BFI	4%	4%
8. Diverse	4%	4%

Community-Based Monitoring

- **Map-based Data Entry**
 - users map their sampling areas
 - monitoring data tied to geographic data
 - visualization of all community sampling areas
- **Report Panel**
 - immediate reporting of publicly collected data
 - specify report parameters (e.g., dates)
 - multiple formats (e.g., PDF, HTML).

A Model of Communication for GIS



Bunch, M. J. (2001). "GIS for Marginalization or Empowerment in Environmental Management: A South Indian Example." The Indian Geographical Journal **77**(2): 1-17.

PPGIS and PGIS

- Grounded in value and ethical frameworks that promote,
 - Social justice
 - Ecological sustainability
 - Improvement of quality of life
 - Nurturing civil society
 - Capacity building
- Applied in the context of partnerships among academe, civil society, government

Traditional GIS vs. PPGIS

GIS	<i>Dimension</i>	PPGIS
Technology	<i>Focus</i>	People and technology
Facilitate official policy-making	<i>Goal</i>	Empower communities
Supply-driven; technological push	<i>Adoption</i>	Demand- and need-driven
Rigid, hierarchical & bureaucratic	<i>Org'l structure</i>	Flexible and open
Because it is possible	<i>Why use it?</i>	Because it is needed
Specified by technologists	<i>Details</i>	Specified by users/focus groups
Led by independent specialists	<i>Application</i>	Led by facilitators/group leaders
General/multipurpose applications	<i>Function</i>	Specific, project-level activities
Top-down	<i>Approach</i>	Bottom-up
Capital-intensive	<i>Cost</i>	Low-cost

(Sieber 2003 as derived from Kyem 2000)

Problems w/ Original Prototype

- Top down approach to development
 - Design (functionality and its implementation) determined by technologists
 - Very limited stakeholder consultation
- Emphasis on functionality, not usability
 - Multipurpose
 - Multiple ways to go about doing things
 - Confusing interface
- Capital intensive (proprietary software)
- Code problems
 - poor coding practices
 - E.g, no commenting, hard-coding hyperlinks
 - no documentation

The Original Site



[HOME](#) • [CONTACT](#) • [SITMAP](#) • [SEARCH](#) •

Protecting Our Water | Protecting Our Land | Learning and Education | Parks and Attractions
Get Involved and Events | Planning and Permits | Conservation Foundation | Corporate Info

THE LIVING CITY

Protecting Our Water

About this Project

Community Monitoring

Report Generator Area (secure)

Administration Area (secure)

Humber Watershed Report

2002



Welcome to the Regional Watershed Monitoring and Reporting Service Pilot Project. The purpose of this pilot project is to provide increased accessibility to aquatic monitoring data, allow for rapid analysis and publishing of indicator information and support the overall goals of the Regional Watershed Monitoring Network. The current geographic scope of this project is limited to the Humber Watershed.

Search for Aquatic Monitoring Information by:

-- select --

-- select --

Postal Code
Enter your postal code (e.g., M3J1P3)

Sub-Watershed
Select a sub-watershed

Station ID
Monitoring station number



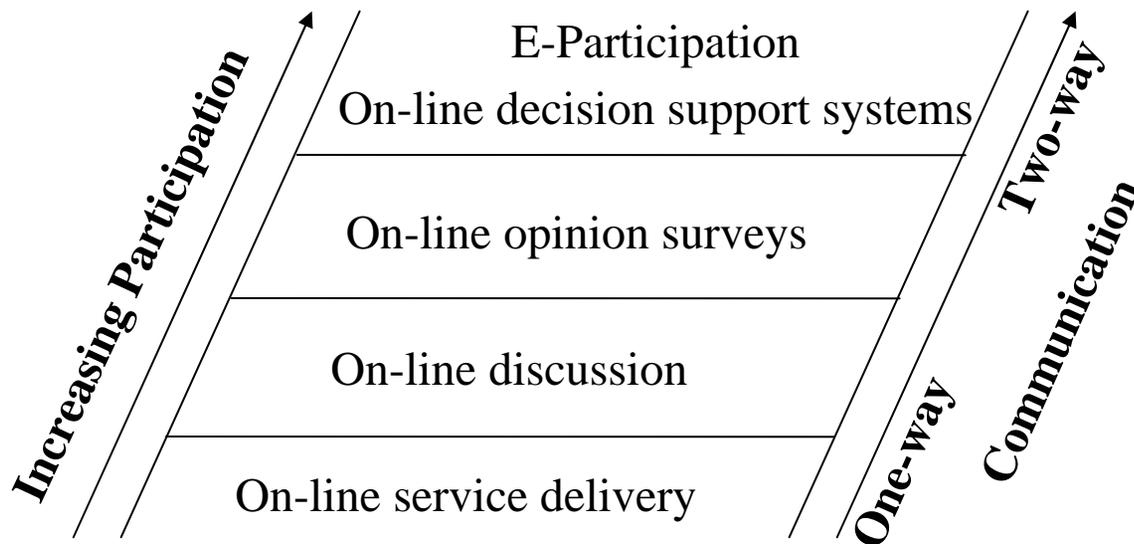
Project Partners:



Need a "How to Use" for this website? [Click here](#)

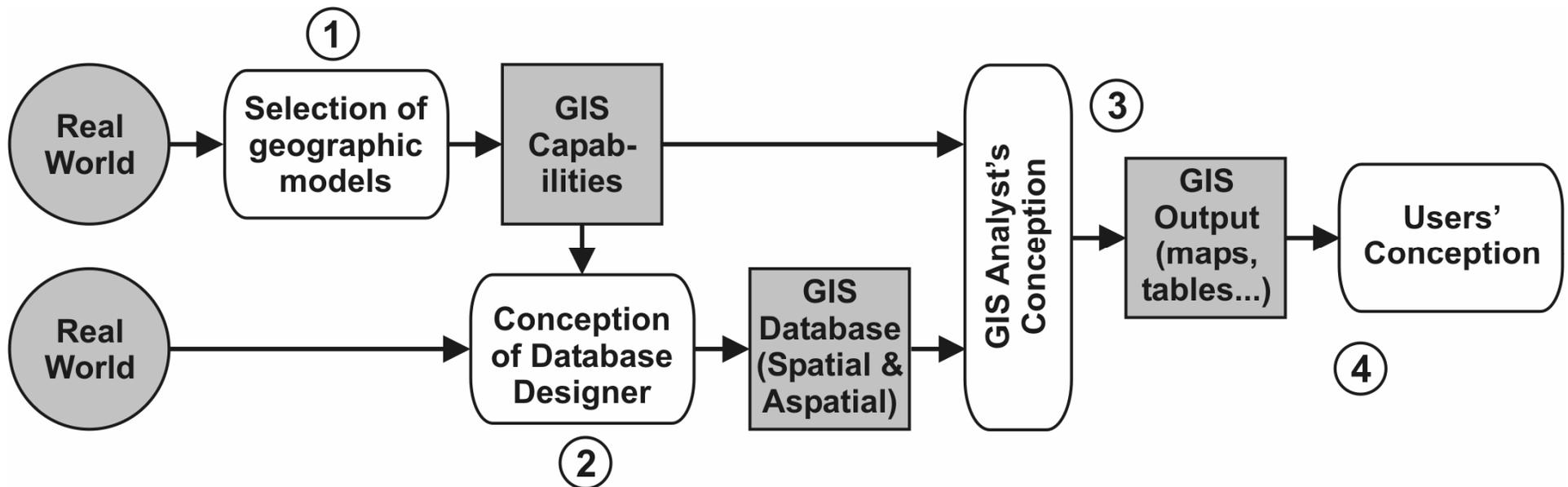
Public Participation and the WWW

- Usability criteria are widely applied in software engineering and computer interface design
- But there is a lack of such an approach for PPGIS



Steinman et al. (2004), adapted for web-GIS based on Arstien (1969)

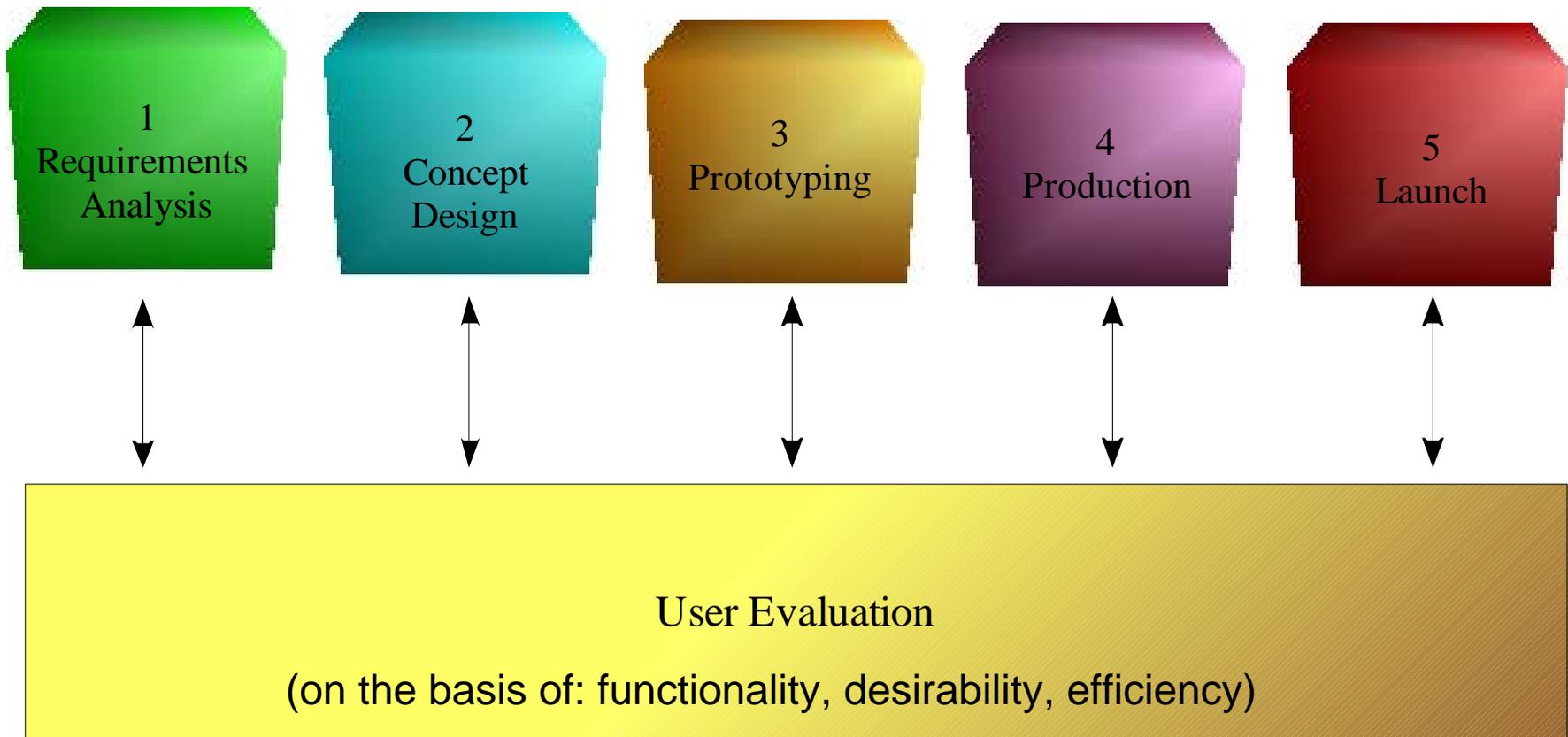
Incorporating Stakeholder Participation into the GIS Production Process



Methodology for Redevelopment

- Iterative Development (ID)
 - Continual refinement via trial and error
 - Each cycle of development informs the next
- 3 stages within each iteration:
 - *Examination* (does the design suit the task?)
 - *Definition* (identifies solutions to problems)
 - *Creation* (solutions implemented)
- Also Informed by
 - Pervasive Usability Process
 - Discount Usability approach

Pervasive Usability



After: Brinck et al., (2000)

Discount Usability

- Performance of usability tests of small sets of users (e.g., five)
 - Captures more than 80% of all interface errors
- 3 Specific Techniques
 - Scenarios
 - ‘Simplified thinking aloud’
 - Heuristic evaluation

1st Iteration: stakeholders

- Identify major stakeholders
 - Volunteer water quality monitors
 - Lay public
 - Outside consultants
 - Web-GIS system administrator
 - TRCA staff
- (representatives of each group became the user ‘testers’)

1st Iteration: stakeholder interviews

- Scripted interviews and testing of the original website.
- E.g., a volunteer user would be asked respond to the following questions, while performing the operation using the web-GIS:
 - You would like to generate a report for the Humber watershed for the 2001 year. How would you generate a report for 2001?
 - You have recently compiled some data from a section of the Humber river. Given that you have to data to upload, how would you upload the data?

1st Iteration: design

- Use cases
 - Narratives: who does what with the system, for what purpose
- Functional requirements list
 - Describes functionality of the system
- Wireframes
 - Lays out the system architecture – can be converted to a minimally functional prototype (front end only, no content)

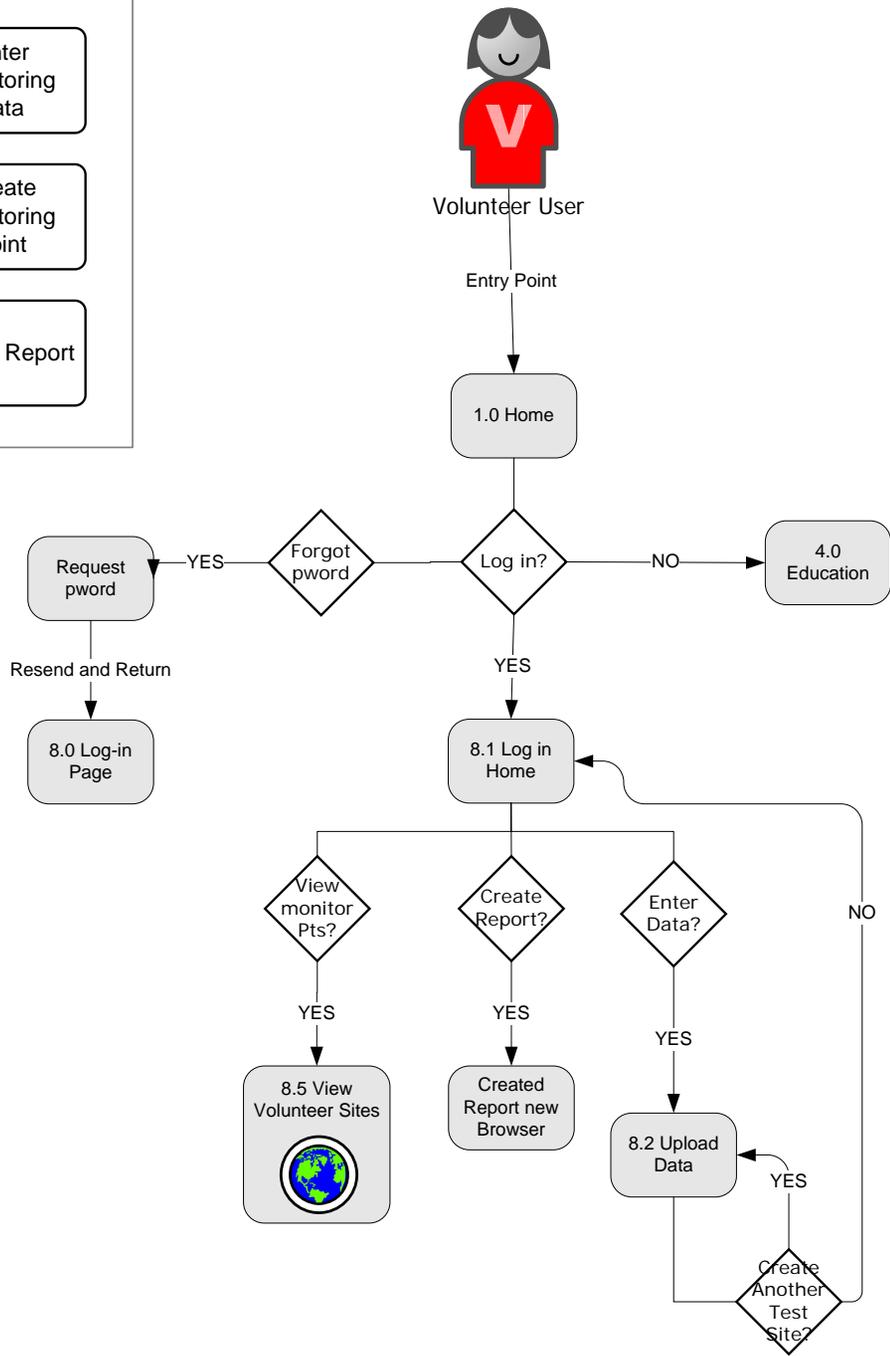
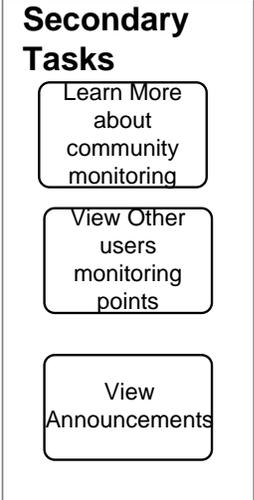
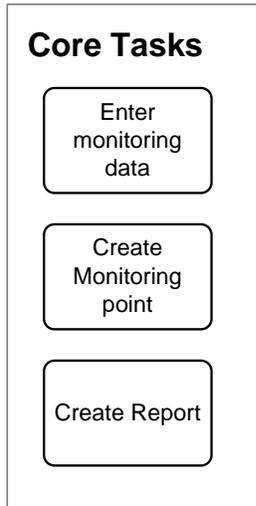
Use Cases: Lay User, Typical Scenario 1

Vincent is a new Canadian who heard about the TRCA community monitoring project from his friend. In curiosity he visits the site to learn more about the project and the methodology for collecting data. As a first Canadian, English isn't his first language but he finds the information on the web site easy to understand and simple to follow. His background in as an engineer in his home country gives him a firm understanding of the basic principles of scientific methodology. He finds himself wanting to learn more about the program and become involved. He clicks a contact us link in the web site and sends an email out to the community monitoring coordinator to find out about the workshop sessions.

He also prints out a report of the subwatershed near his home to show his friends and family. The report summarizes assessments of fish, benthic and other stream health indicators for each water monitoring station, subwatershed, watershed or municipality covered in the system. The simple explanations and graphical features incorporated in these reports allow him to easily visualize the overall health of the subwatershed.

Functional requirements list derived from use cases

Juturna Web site Redevelopment					
Prepared By: Martin Bunch and Michael MacLennan					
Site Map Code	#	Content / Tertiary / Functionality	Description/Purpose	Considerations and Notes	Phase
					P1 P2
N/A Global Elements (present on every page except Home page)					
	0.1	Link to home page			x x
	0.2	Link to GTA watersheds	Humber River, Eobicoke and Mimico Creeks, Don River Duffins and Camthers Creeks, Highland Creek, Rouge River, Peticot creek		x x
	0.3	Link to TRCA Monitoring Stations	Update-able with other watershed as they become integrated		x x
	0.4	Watershed report Summaries			x x
0.0 Home Page					
	1.0	User Log in and Registration	Promote new <u>online</u> services and direct volunteers to log in area	Simple instructions	x x
	1.1	Welcome and About information	Welcome information and a brief summary about the project and site	Concise information summary	x x
	1.2	Toronto Watersheds health summary	Report summary of current <u>Humber</u> Watershed health	Initial this can be static but would like to be dynamic as data changes to does report	x x
	1.2.1	Toronto Watersheds health summary	Report summary of current <u>Humber</u> Watershed health as separate frame in page	Dynamically derived real time Watershed Health Summary	
	12.2	Links to Watersheds and Sub-watersheds		Only <u>Humber</u> watershed information is functional in this version. System will be immediately extensible to other watersheds as data for them becomes available.	x
	1.3	Link to other watershed Information	Links to report summaries of other watersheds (update-able)		x x
	1.4	Link to TRCA Monitoring Stations			x x
	1.5	Link to Watershed Report Summaries			x x
0.1 Global Elements (Only at Home Page)					
	2.0	Link to TRCA site	Optimize overall design for implementation with existing TRCA site	Links to corresponding content on the TRCA site	x x
	2.1	Site wide Search	Optimize overall design for implementation with existing TRCA site	Will search site pages as well as <u>metadata</u>	x x
	2.2	Site Map	Optimize overall design for implementation with existing TRCA site	Link to complete site map	x x
	2.3	Contact Information	Optimize overall design for implementation with existing TRCA site	Detailed information summarizing	x x



User flows: community volunteer

Home Page

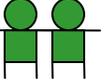
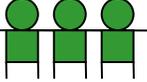
Image	TRCA Logo
Home Watersheds Monitoring Stations Education Get Involved Partners Contact Us	
<h3>Watershed report summary</h3> <p>Consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum.</p> <p>Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue dui dolore te feugait nulla facilisi. Nam liber tempor cum soluta</p> <p style="text-align: right;">Produce Reports</p>	<h3>User Login</h3> <p>Username: <input type="text"/></p> <p>Password: <input type="password"/></p> <p style="text-align: center;"><input type="button" value="Log in"/></p> <p style="text-align: center;">Forgot password</p>
<h3>About Site/Project</h3> <p>Consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum.</p>	<h3>Request Account</h3> <p>Consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna.</p> <p style="text-align: center;">Request Account</p>

Example
of a
wireframe

2nd and 3rd Iterations

- User testing using wireframes
 - This leads to a functional prototype
- User testing with an almost complete prototype
 - This leads to a version of the system that can be used to support the water quality monitoring program

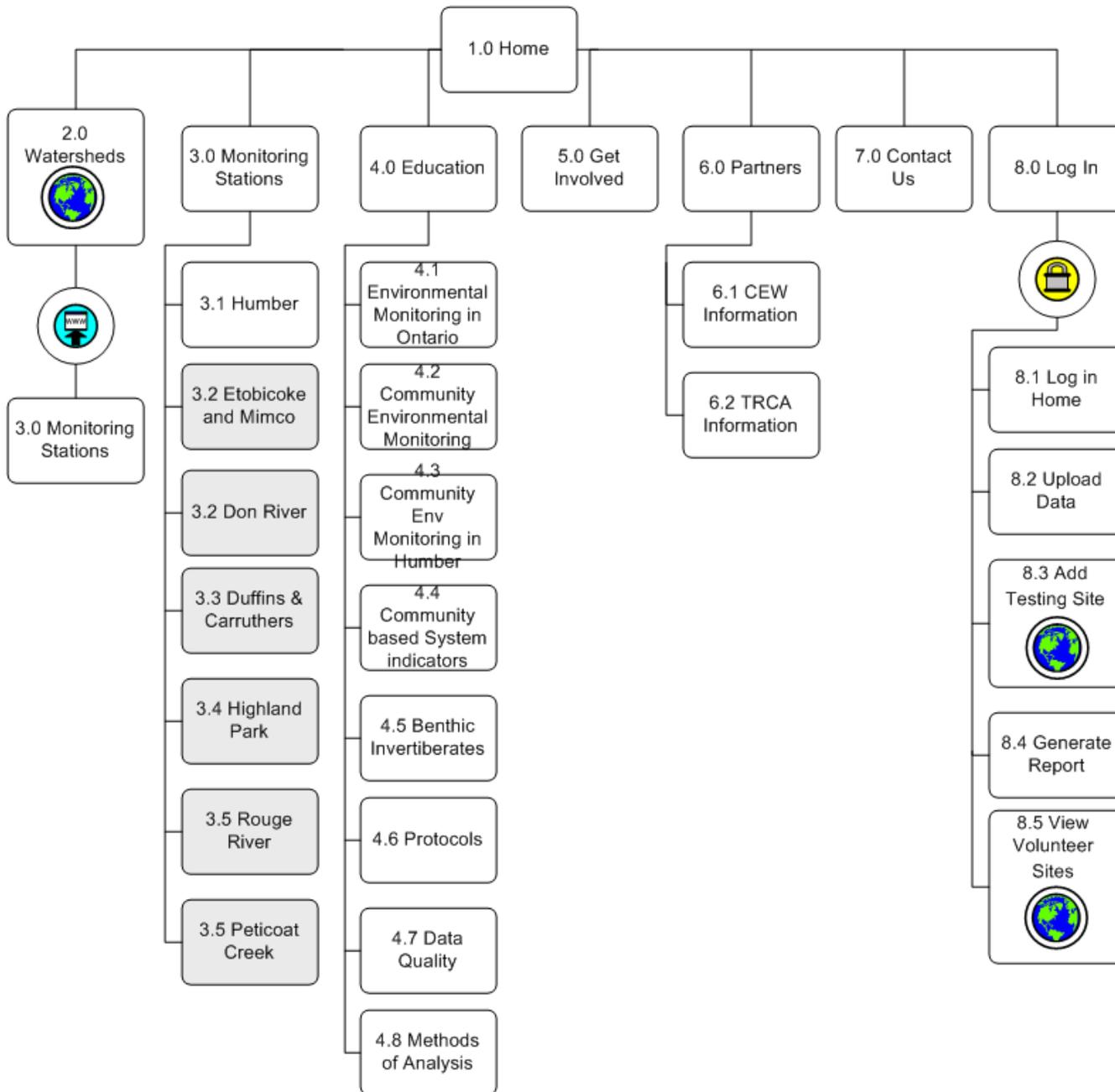
Conversion to Free and Open Software (FOSS)

- Original web-GIS -\$\$\$ 
 - MS Windows Server
 - ArcIMS
 - Crystal Reports
 - SDE
 - SQL, Java Script, Java Bean, Map Objects Java, VB Script, ASP, HTML
 - Some proprietary data (postal codes)
- New web-GIS-\$ 
 - Linux (Fedora)
 - MapServer
 - Postgresql/PostGIS
 - FOSS Metadata catalogue
 - SQL, Ruby on Rails, HTML, AJAX
 - No proprietary data that is not already owned by stakeholders

Basic functionality

- Data upload
- Data download
- Data analysis
- On the fly report generation
- Biomonitoring and watershed education
- Administrator tasks
 - User account management
 - Data assessment

Local Navigation Structure



Improved
system
architecture
and data
flows



HOME CONTACT SITEMAP SEARCH

Welcome

Discover Toronto's Watershed

Learn about Watershed Monitoring

Become a Watershed Monitor

Our Partners

To search for specific monitoring stations use the map below. Or click on one of the following for watershed specific information:

|Humber| |Etobicoke and Mimico| |Don River| |Highland Creek| |Rouge River| |Duffins and Carruthers|



Humber Watershed

Click here for Help

Easting=603884.89 , Northing=4859803.08



Map Components Legend

- Volunteer Site
- Aquatic habitat Station
- Precipitation Gauge
- Snow Gauge
- Fluvial Station
- Stream Gauge
- Streams
- Toronto Area Roads
- Humber Subwatershed
- Watersheds



Screenshot from Juturna v 2: "Discover Toronto's Watershed"



Screenshot: Education/Information functions



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Welcome

Discover
Toronto's Watershed

Learn about
Watershed Monitoring

Become a
Watershed Monitor

Our Partners

What is Watershed
Monitoring?

Humber

Etobicoke and Mimico

Don River

Duffins and Carruthers

Highland Creek

Rouae River

Community Based Environmental Monitoring

Community Based Environmental Monitoring (CBEM) is a process through which citizens can actively participate in monitoring their local environment. Environmental monitoring organizations seek to reconnect citizens and students with the natural environment and spark an interest in and commitment to environmental stewardship. Many of these groups can provide training and even equipment to help community groups collect reliable monitoring data that reflects some important aspects of environmental health or issues of concern.

Participants of community based monitoring programs may benefit from the experience in several ways:

- ◆ Data collected may be used to enhance or support scientific data collected by other scientists. Although data collected by community members may not have the same level of detail as that collected by professionals, with proper training and methods, community data can be a valuable



Data upload

[Home](#)

[Upload Your Benthic Data](#)

[Explore Volunteer Sites](#)

[Create a Water Monitoring Report](#)

[Help](#)

[Log Out](#)

Benthic

Benthos Collection Method

Kick and Sweep

Collection Method Description

Name	Value	Name	Value
Acarina(Water Mite)	<input type="text"/>	Isopoda(Aquatic Sowbug)	<input type="text"/>
Amphipoda(Scud)	<input type="text"/>	Megaloptera(Dobsonfly,Alderfly,Fishfly and Helgrammite)	<input type="text"/>
Anisoptera(Dragonfly)	<input type="text"/>	Oligochaeta,Nematoda(Worm)	<input type="text"/>
Chironomidae(Midge)	<input type="text"/>	Pelecypoda(Clams)	<input type="text"/>
Coleoptera(Beetle)	<input type="text"/>	Plecoptera(Stonefly)	<input type="text"/>
Culicidae(Mosquito)	<input type="text"/>	Simuliidae(Blackfly)	<input type="text"/>
Decapoda(Crayfish)	<input type="text"/>	Tabanidae(Horsefly)	<input type="text"/>
Ephemeroptera(Mayfly)	<input type="text"/>	Tipulidae(Crane-fly)	<input type="text"/>
Gastropoda(Snail)	<input type="text"/>	Trichoptera(Caddisfly)	<input type="text"/>
Hemiptera(True Bug)	<input type="text"/>	Turbellaria(Flatworm)	<input type="text"/>
Hirudinea(Leech)	<input type="text"/>	Zygotera(Damsefly)	<input type="text"/>
Unidentified	<input type="text"/>		

Conclusions

- Involving users in the production process of PPGIS has resulted in an information sharing and monitoring facilitation tool that:
 - Has less functionality, but more usability (less “bling” more zing!)
 - Is more affordable to the host organization
 - Broadens the potential community of users
 - Can be maintained and extended!

Thanks!

Contact:

Martin J. Bunch

Faculty of Environmental Studies

York University

bunchmj@yorku.ca

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