A Public Participatory Geographic Information Systems (PPGIS) approach to the impacts of climate change on water resources. The South Saskatchewan River Basin.

Lorena Patiño and David Gauthier
University of Regina. SSHRC-MCRI Institutional Adaptation to Climate Change Project.
The Canadian prairies have been identified as potentially vulnerable and at risk of the impacts of climate change (Environment Canada, 2004).
Integrated Water Resource Management (IWRM)

Ecological Approach

Dimensions of Sustainable Development

Good Governance & Public Participation

Institutional Levels

- **Federal** → **Local**
- **Government** → **Civil**
- **Formal** → **Informal**

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Federal Principles and Main Instruments that Affect the Water Institutional Dynamic in the South Saskatchewan River Basin.


### PRINCIPLES
- Water is generally considered a public good.
- Water is managed under a governmental decentralized structure and shared jurisdictional management.
- Water management is based on the principles of sustainable development and integrated water resource management.
- Governance of water is based on communication and shared decision making (cooperative federalism) between all governmental levels and stakeholders involved.

### INSTRUMENTS

#### Constitution Act, 1867.
- Amendment, Natural Resources Transfer Agreement, 1930. Provinces acquired ownership of natural resources within provincial boundaries including water.
- Shared responsibility occurs in inter-provincial, agricultural and health related water issues.
- Federal government could invoke exceptional powers to assert jurisdiction to water under provincial jurisdiction: "declaratory power"; "spending power"; "peace, order and good government".

#### The Canadian Water Act, 1985
- Federal government has powers on waters on federal lands, inter-jurisdictional waters, and waters where water quality management has become a matter of urgent national concern, the Minister of Environment may enter into an agreement with one or more provinces to designate a water quality management area.

#### The Fisheries Act, 1985
- Federal government retains responsibility for the protection of fish and fish habitat.

#### Navigable Waters Protection Act, 1985
- Federal government retains responsibility for the protection of navigable waters.

#### Federal Water Policy, 1987
- Underlying philosophy: water must be seen both as a key to environmental health and as a scarce commodity having real value.
- Overall objective: to encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations.
- The policy demonstrates leadership by committing to develop and apply the concept of "a fair value for water."
- Calls for an effective mechanism developing anticipatory and preventive approaches to managing the quality and quantity of water resources acknowledging their value in social, economic and environmental terms.
- Calls for a joint and co-operative management approach with the provinces.

### ISSUES
- Water as a public good, under a decentralized government structure and shared jurisdictions, based on sustainable development and integrated water resource management, and governance based on cooperation and communication, involves:
  - federal-provincial agreements, and local decision-making.
  - federal and provincial governments set guidelines, standards and regulations for water management.
  - active day-to-day management of water is increasingly undertaken by smaller local institutions.

- Potential disagreement and/or conflict between actors involved in agreements.

- Agreement process has the potential of preventing effective and timely decision-making.

- Local institutional level lacks necessary authority and funding.

The **Federal Water Policy** although with sound policy recommendations, has not been fully acted upon, and a national strategy has not been developed.

Canadian water law establishes that the Federal Crown owns water resources and has power on waters listed below under *The Canadian Water Act, 1985*. Provinces have jurisdiction over natural resources, including water resources, under the Natural Resources Transfer Agreement, 1938.

### WATER QUALITY: ENVIRONMENT

- **Migratory Bird Regulations**

### ENVIRONMENT CANADA

**The Canadian Water Act, 1985**

In relation to waters on federal lands, inter-jurisdictional waters, and waters where water quality management has become a matter of urgent national concern, the Minister of Environment may enter into an agreement with one or more provinces to designate a water quality management area.

**Consensus approach**, were provincial governments, as primary regulator of water supplies, have always complied with the Agreement.

**Intended to guarantee the most economically/beneficial mixture of water uses.**

**Water right allocation (including priorities of types of use) are left to the discretion of the officials of the corporation (bureaucratic as opposed to statutory resolution).**

### WATER QUANTITY

- **WATER ALLOCATION**

### Membrane Agencies

- **pRAIRIE PROVINCES WATER BOARD** (1948 and reconstituted in 1969)
  - Report and issue recommendations to its members’ agencies. Cooperative Federalism Model.*

### Provinces have jurisdiction over natural resources, including water resources.

- **PROVINCE OF ALBERTA**
  - Provinces have jurisdiction over natural resources, including water resources.

- **PROVINCE OF SASKATCHEWAN**

### Person responsible for water works

- **Federal level**
- **Inter-jurisdictional level**
- **Provincial level**
- **Local level**

### Canadian Environmental Assessment Agency

*(The Canadian Environmental Assessment Act, 1992)*

Accountable to the Minister of the Environment.

### ALBERTA ENVIRONMENT

*(Based on the principle of "wise use" and "most beneficial use of water")**

**The Environmental Protection and Enhancement Act (EPEA), 1992.**

**The Water Act, 2000.** Introduces the ability to transfer water licenses.

### ALBERTA HEALTH WELLNESS

**The Health Act, 1994**

### SASKATCHEWAN WATERSHED AUTHORITY

**The Saskatchewan Watershed Authority Act, 2005**

(Follows the Crown Corporation Model***)

### MANITOBA WATER STEWARDSHIP

**The Environmental Protection and Enhancement Act (EPEA), 1992.**

### PRAIRIE FARM REHABILITATION ADMINISTRATION - AGRICULTURE AND AGRI-FOOD CANADA

**The Canadian Water Act, 1985.** Introduces the ability to transfer water licenses.

### WATER QUALITY

- **POTABLE WATER**
- **ENVIRONMENT**

### ALBERTA ENVIRONMENT

**The Environmental Protection and Enhancement Act (EPEA), 1992.**

### ENVIRONMENTAL APPEALS BOARD

**The Health Act, 1994**

### SASKATCHEWAN HEALTH

**The Saskatchewan Watershed Authority Act, 2005**

(Follows the Crown Corporation Model***)

### SASKATCHEWAN ENVIRONMENT AND RESOURCE MANAGEMENT


### SASKATCHEWAN WATERSHED AUTHORITY

**(Saskatchewan Watershed Authority Act, 2005)**

(Follows the Crown Corporation Model***)

### WATER APPEAL BOARD

*(Water Appeal Board Act, 2002)*

### WATER QUANTITY

- **WATER ALLOCATION**

### WATER ALLOCATION

- **MUNICIPALITIES**
- **LOCAL ADVISORY COMMITTEES**

GOVERNMENT
- FEDERAL
  - Environment Canada
  - Health Canada
  - Natural Resources Canada
- Agriculture and Agri-Food Canada
- Fisheries and Oceans Canada

INTER-JURISDICTIONAL
- Prairie Provinces Water Board

SASKATCHEWAN
- Saskatchewan Watershed Authority
- Saskatchewan Environment
- Saskatchewan Health
- Saskatchewan Agriculture and Food
- SaskWater
- SaskPower

ALBERTA
- Alberta Environment
- Community Development
- Alberta Health and Wellness
- Alberta Agriculture, Food and Rural Development
- Sustainable Resource Development
- Alberta Infrastructure and Transportation

PROVINCIAL
- AB Water Council

SASKATCHEWAN
- Regional Health Authorities

ALBERTA
- Regional Health Authorities

LOCAL
- Local Regional Public Health officers
- Local advisory Committees
- Municipalities
- Person responsible for Waterworks Systems

NON-GOVERNMENTAL ORGANIZATIONS
- GOVERNMENT MUNICIPALITIES
- SaskPower
- Local advisory Committees
- Regional Health Authorities

SCOPE: RESEARCH
- Universities
- NWRI*
- SRC**
- ARC***

SCOPE: ENVIRONMENT
- Ducks Unlimited
- Nature Conservancy of Canada
- SASKATCHEWAN (SK)
- SK Wildlife Federation
- SK Environmental Society
- ALBERTA (AB)
- Cow and Fish
- Bow Riverkeeper

SCOPE: POLICY
- SASKATCHEWAN (SK)
- Canada West Foundation
- The Pembina Institute
- ALBERTA (AB)

SCOPE: ADVOCACY
- Pollution Probe
- Sierra Club Canada
- Greenpeace

SCOPE: WATERSHED STEWARDSHIP/PARTNERSHIP - REGIONAL
- Partners for the Saskatchewan River Basin

SCOPE: IRRIGATION – REGIONAL
- Watershed Stewardship Groups (e.g. Cows and Fish, AB Stewardship Network)
- The Swift Current Creek Watershed Stewards
- Watershed Planning and Advisory Councils (e.g. North Sask., Bow & Oldman basins)

SCOPE: RURAL WATER UTILITIES – LOCAL
- Sask. Association of Rural Water Pipelines, Inc.
- Alberta Federation of Rural Water Cooperatives Ltd.

*National Water Research Institute; **Saskatchewan Research Council; ***Alberta Research Council.

LEGEND
- National level
- Provincial level
- Regional level
- Local level
DRAFT - Blood Tribe community vulnerability to climate change focused on water.

Derived mainly from Lorenzo Magzul (with Alejandro Rojas). 2007. Report on the Blood Tribe (Kainai Nation): community vulnerabilities. IACC Project, Unit 1 A: An assessment of vulnerabilities of rural communities and households to water related climate conditions (Chile and Canada)

CURRENT VULNERABILITY TO CLIMATE RELATED EVENTS

Flood
  Impacts on population: mainly housing and road network

Drought
  Impacts on corporations: irrigated agricultural land; rain-fed agricultural land; Grass fire

CURRENT LIVELIHOOD ADAPTIVE STRATEGIES

ADAPTIVE CAPITALS (see capitals’ description on next page)

Natural Capital
  Agricultural land (almost 60% of the land); Climate, i.e. rain-fed agriculture; River system: to support irrigation for agricultural activities; Forestry (1% of land); Oil and gas; Gravel.

Financial Capital
  Integration of economic agricultural venues; Crop and home insurance; Start up loans; government assistance; tax exemption.

Human Capital
  Self-run education system; self-running post secondary education; elders traditional knowledge; efforts to maintain Blackfoot language; water management skills; flood mitigation skills. Healthier diet awareness.

Social Capital
  Exhibits of community support system.

Technological Capital
  10% of agricultural land has computerized; irrigation system; public treatment of drinking water (quality); Improved equipment for flood emergencies.

Institutional Capital
  Internal Formal Institutions: Local government structure in place; Appreciation for drinking water; Adaptive management initiatives; Identification & program development of community needs.

External Formal Institutions: Disaster relief; Federal and provincial funding for agricultural development project; Improved communication with provincial government regarding dams during flooding events; Preventive diabetes programs.

Production & income
  -Majority of population is under gov. assistance ($234 a month, 2005).
  -10 to 12% of population has occupancy rights on the land, leasing 90% of the agricultural land (rain-fed land) to non-natives.
  -Cultivation of agricultural land by Band members (Irrigated land: 10% of agricultural land)
  -Migration for employment opportunity.
  -Band’s departments and agencies (only a handful of jobs)
  -Hunt and fish to supplement food.
  -Buy groceries in bulk – Engage in small and informal business.

Consumption activities
  -90% of agricultural land (rain-fed land) rented to non-natives mainstream farmers: claims of depletion of soil nutrients (needs to be tested).
  -10% of agricultural land under irrigated cultivation by Blood Tribe Agricultural Project (Band members) – use of high end technology: machinery and irrigation.

Process, exchange, market activities
  Internal process: unequal distribution of land tenure occupancy rights that benefits only about 10 to 12% of the population.
  Grain global market: worldwide depressed grain prices threaten the viability of grain farming.
  Regional market: off-reserve leasing fees of agricultural lands are approximated 50% less than leasing fees within reserve lands.

CURRENT EXPOSURES AND CONSTRAINTS

Environmental
  Climate (Droughts, Floods); BSE; water quality (drinking water)

Physical
  Inadequate infrastructure (roads, Irrigation)

Economic
  Land tenancy system; lack of access to capital related to land tenure system; lack of economic activity and entrepreneur initiatives; high unemployment; welfare dependency; poverty; dependence on on-native Farmers.

Social
  Weak social cohesion and networks; erosion of traditional values, beliefs and principles, and unresolved issues of abuse and victimization, producing; social breakdown- manifested in: drug and alcohol abuse, addictions, community and family violence, suicide, gangs, child neglect; problems In town sites; lack of recreation programs; shortage of housing (overcrowding) and poor housing conditions; social stratification.

Human
  Lack of education and working skills; Health weaknesses: diabetes, cancer and fetal alcohol syndrome; lack of parenting skills.

Institutional
  a) external formal arrangements
     Imposed governance system (Institutional policies: Indian Act, Residential schools, Social Welfare); establishment of town sites; federal and provincial agreements; negative influence of traditional societies.
  b) internal formal arrangements
     Elective system; questioning of Chief and Council’s legitimacy and credibility (mistrust), accountability and transparency; perceived weak leadership of Chief and Council, managers and directors of the various Blood Tribe agencies; nepotism.
Public Participatory Geographic Information Systems (PPGIS) ?

It is a process of social construction (*i.e.*, meaning); it is a collaborative process between machine and people/community.


Is an interdisciplinary research, community development and environmental stewardship tool grounded in value and ethical frameworks that promote social justice, ecological sustainability, improvement of quality of life, redistributive justice, nurturing of social civic society, etc.

Is multidisciplinary, integrates outside expert knowledge with socially
differentiated local knowledge. In addition, PPGIS 'builds on high levels
of stakeholders' participation in the processes of spatial learning,
analysis, decision making and action'

Integrate multiple realities and diverse forms of information to foster
social learning, support two/multi-way communication and broaden public
participation across socio-economic contexts, locations and sectors'

Rambaldi G., Kwaku Kyem A. P.; Mbile P.; McCall M. and Weiner D. 2005. Participatory Spatial Information Management and
Communication in Developing Countries. Paper presented at the Mapping for Change International Conference (PGIS'05), Nairobi, Kenya,
7-10 September 2005.
• Geographic
• Information
• System

Map
Data
Computerized

Measurements
Tabular information (Attributes)
What is a Geographic Information Systems (GIS)?

GIS is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

Traditional components of a GIS

Traditional approach for the integration of information.

Biophysical information

Socio-economic information

SIG

Software Tools + Abstraction or Simplificación

The Real World

OUTPUT

Top-down
Public Participation (PP)

Public

WHO?

Participation

WHY?
Public Participation

Empowerment and social interaction perspective:

Collective effort of stakeholders, stimulated by a sense of self-deliberation, the creation of free and independent organizations, voluntary efforts, and sense of sharing risk, responsibilities, resources and benefits. The objective of those involved is of auto-development and the acquisition of a place in the decision making process.

“Participation” refers to a horizontal relationship where different realities and different modes of enquiry are acknowledged, facilitating the dialogue and promoting knowledge exchange, as well as a continuous learning or co-learning process between all those involved (Boothroyd et al., 2004; Montero, 2004).


### Participation: scale of purposes

<table>
<thead>
<tr>
<th>Author</th>
<th>Orientation</th>
<th>Spectrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arnstein (1969)</td>
<td>Power</td>
<td>Manipulation → Citizen control</td>
</tr>
<tr>
<td>Weidemann and Femers (1993)</td>
<td>Administrative</td>
<td>Education → Joint decision making</td>
</tr>
<tr>
<td>Conner (1988)</td>
<td>Conflict resolution</td>
<td>Education → Prevention</td>
</tr>
<tr>
<td>Dorcey et al. (1994)</td>
<td>Planning process</td>
<td>Information → Constant involvement</td>
</tr>
</tbody>
</table>

### Concepts of Public

<table>
<thead>
<tr>
<th>Author</th>
<th>Dimension</th>
<th>Public Typology Focalized</th>
<th>Amorphous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggens</td>
<td>Energy and interest, time, and resources.</td>
<td>Decision-makers → Unsurprised apathetic</td>
<td></td>
</tr>
<tr>
<td>Mitchell et al.</td>
<td>Power, legitimacy, and urgency</td>
<td>Definitive → Latent stakeholders</td>
<td></td>
</tr>
<tr>
<td>Thomas</td>
<td>Organizational complexity</td>
<td>One group → Complex group</td>
<td></td>
</tr>
</tbody>
</table>

- Public selection

- Willeke Relevant public Self-selection → third part
- Creighton Affected public Spatial proximity → values alignment

PPGIS
Public Participatory Geographic Information Systems


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INTEGRATION

VALUES AND PERCEPTIONS

bottom-up approach

Local Knowledge

Social sciences
Subjective
Qualitative
Contextual (local)

Hard sciences
Objectivity
Quantitative
Generalities

Expert knowledge

top-down approach

INFORMED

COLLABORATION & SOCIAL INTERACTION

INTERACTION PROCESS

Captions:
www.iapad.org
(Integrated Approach to Participatory Development)

© Lorena Patino, University of Regina.)
PPGIS: Reflective and an informed interactive process

Integration of values and perception;
Empowerment;
Collaboration institutions;
Social learning;
Social capital;
Human capital.
PPGIS model for integrating multiple realities of water resource management.

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FUTURE CLIMATE CHANGE SCENARIOS

- increase in drought intensity and frequency (warmer longer summers)
- increase in flooding intensity and frequency (mainly in spring)

Water
- water quality (particularly in drinking water)
- water quantity (rain resource for agricultural activity, both rain-fed and irrigation-reservoir; wells drying up.)

Process, exchange, market activities
- Internal process: unequal distribution of land tenure occupancy rights that benefits only about 10 to 12% of the population.
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Implications
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Blood Tribe Community
Past and Future Temperatures

Bars show the range in 2100 produced by several models.

Scenarios:
- A1B
- A1T
- A1FI
- A2
- B1
- B2
- IS92a

Several models all SRES envelope.
Comparison of Six Global Climate Models...

Utilizing the example A2 atmospheric chemistry scenario provided by the Intergovernmental Panel on Climate Change, six internationally recognized global climate models each show very similar trends in temperature changes for a point in south-central Saskatchewan for the 2020s, 2050s, and 2080s. Results from the median Canadian, British and Australian models have been used by the Canadian Plains Research Center and Saskatchewan Environment in modeling future ecosystem changes.

— climate model data: Canadian Institute for Climate Studies, University of Victoria; graphic: SK Environment
climate model data: Canadian Institute for Climate Studies, University of Victoria
Vegetative Transition Occurs as the Ecosystem Dries....

- **Coniferous Woodland**
  - (dominated by coniferous tree species)

- **Mixed Coniferous and Deciduous Woodland**
  - (dominated by mixed coniferous and deciduous tree species)

- **Deciduous Woodland**
  - (dominated by deciduous tree species)

- **Mixed Shrub Complex**
  - (dominated by mixed medium and tall shrub species)

- **Mixed Grassland Complex**
  - (dominated by mixed grass and forb species)

- **Desiccating Grassland**
  - (degeneration toward a significantly compromised vegetative state)

- **Disintegrating Grassland**
  - (degeneration toward a nonvegetative state with structural disintegration)

- **Desertification**
  - (transition toward an arid ecosystem with establishment of xerophytic species)

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*Desiccating Grassland, southeast of Val Marie in southwestern Saskatchewan. Photo: Jeanette Pepper*