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.

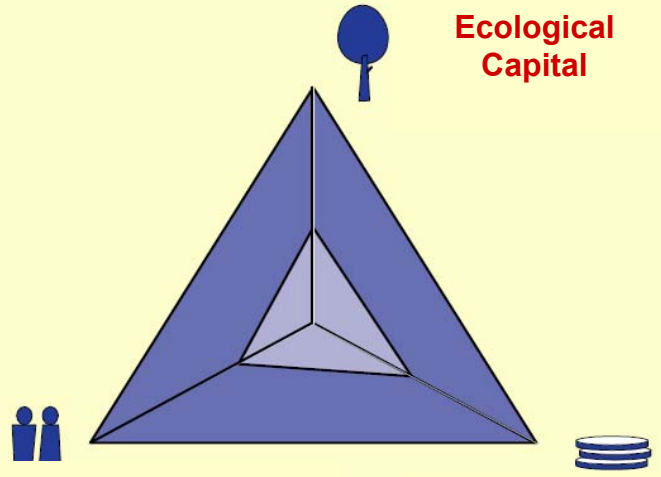
UNIVERSITY OF REGINA
Social Sciences and Humanities Research Council of Canada
Conseil de recherches en sciences humaines du Canada
Canada
UNIVERSIDAD DE LA SERENA

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



Brabant Centre for Sustainable Development (www.telos.nl)

Good Governance & Public Participation

Institutional Levels

Federal → Local

Government → Civil

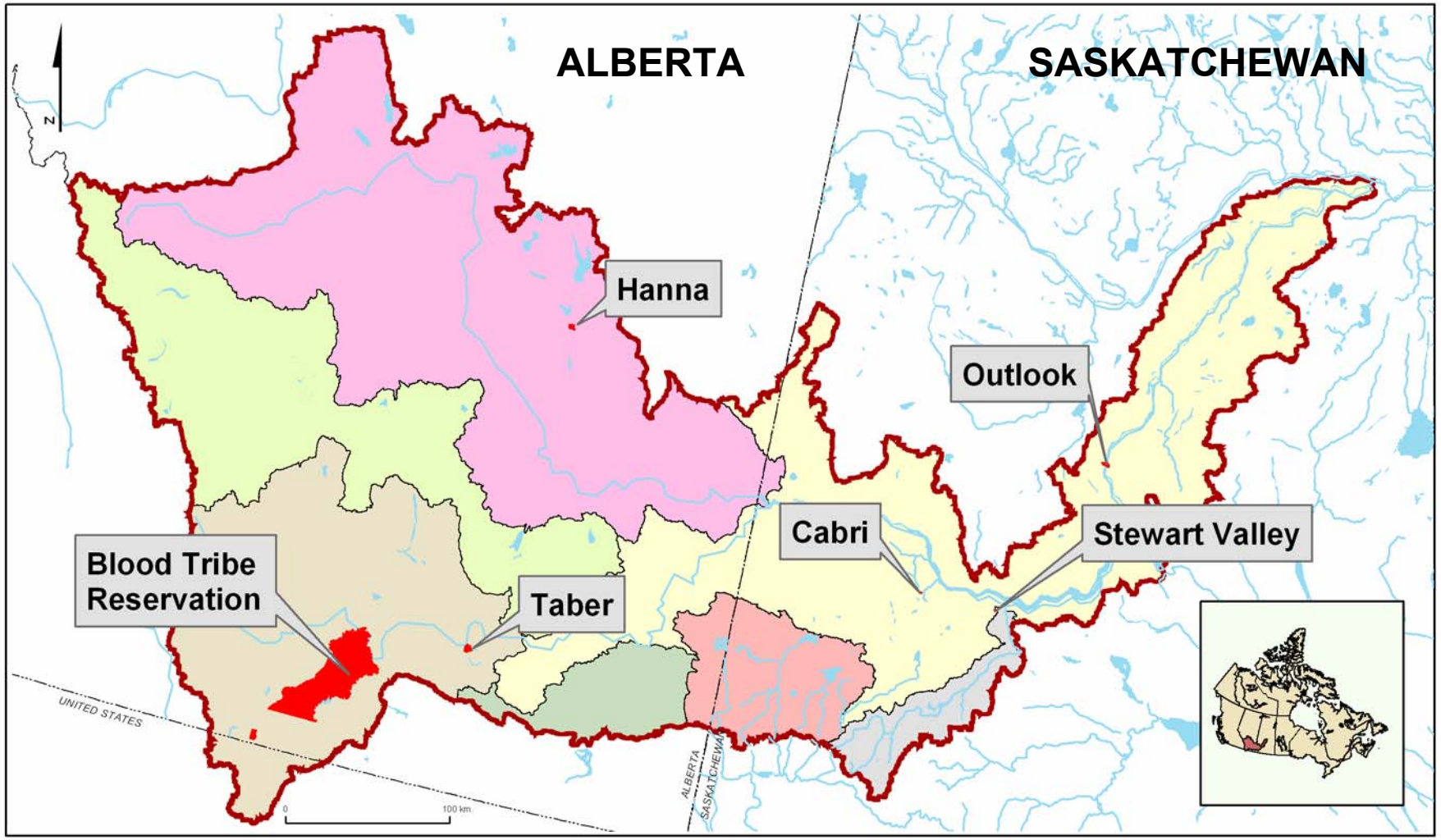
Formal → Informal

Caption: www.iapad.org

© Lorena Patino, University of Regina.

Selected Communities in the South Saskatchewan River Basin (SSRB).

(Map prepared for the IACC project - November 2005)



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

Derived by L. Patiño and D. Gauthier mainly from Corkal, D. R., Inch, B. and P.E. Atkins (AAFC-PFRA). 2007. The Case of Canada – Institutions and Water in the South Saskatchewan River Basin; and also from Hurlbert, Margot. 2006. Water Law in the South Saskatchewan River Basin. IACC Project working paper No. 27.

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.

*Environment Canada. 1985. Federal Water Policy. http://www.ec.gc.ca/water/en/info/pubs/fedpol/e_fedpol.pdf. Updated: July 19th, 2006. Accessed: March 10th, 2007.

South Saskatchewan River Legal and Inter-jurisdictional Institutional Water Map

Derived by L. Patiño and D. Gauthier, mainly from Hurlbert, Margot. 2006. Water Law in the South Saskatchewan River Basin. IACC Project working paper No. 27.

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

FISHERIES AND OCEANS CANADA (*The Fisheries Act,* 1985)

Canadian Environmental Assessment Agency (*The Canadian Environmental Assessment Act*, 1992) Accountable to the Minister of the Environment.

ENVIRONMENT CANADA

Migratory Bird Regulations

***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**.

Constitution Act, 1867

Declaratory power; spending power; and, peace, order and good government, allow to assert jurisdiction to provincial water.

WATER QUALITY ENVIRONMENT

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

WATER QUANTITY WATER ALLOCATION

Water Quality Agreement, added to Master Agreement on Apportionment amended in **1992.**

Master Agreement on Apportionment, 1969.

MEMBER AGENCIES

- **ALBERTA ENVIRONMENT**
- **SASKATCHEWAN WATERSHED AUTHORITY**
- **MANITOBA WATER STEWARDSHIP**
- **PRAIRIE FARM REHABILITATION ADMINISTRATION - AGRICULTURE AND AGRI-FOOD CANADA**
- **ENVIRONMENT CANADA**

PROVINCE OF ALBERTA

Provinces have jurisdiction over natural resources, including water resources.

WATER QUALITY

POTABLE WATER

ENTVIRONMENT

WATER QUANTITY WATER ALLOCATION

ALBERTA HEALTH WELLNESS

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.

ENVIRONMENTAL APPEALS BOARD

PERSON RESPONSIBLE FOR WATER WORKS

PROVINCE OF SASKATCHEWAN

WATER QUALITY

POTABLE WATER

ENVIRONMENT

WATER QUANTITY WATER ALLOCATION

SASKATCHEWAN HEALTH (*The Health Act,* 1994)

SASKATCHEWAN ENVIRONMENT AND RESOURCE MANAGEMENT (*Env. Management and Protection Act*, 2002; *The Environmental Impact Assessment Act*, 2002)

SASKATCHEWAN WATERSHED AUTHORITY (*Saskatchewan Watershed Authority Act,* 2005) (Follows the Crown Corporation Model***)

WATER APPEAL BOARD (*Water Appeal Board Act,* 2002)

MUNICIPALITIES

LOCAL ADVISORY COMMITTEES

Federal level	Inter-jurisdictional level
Provincial level	Local level

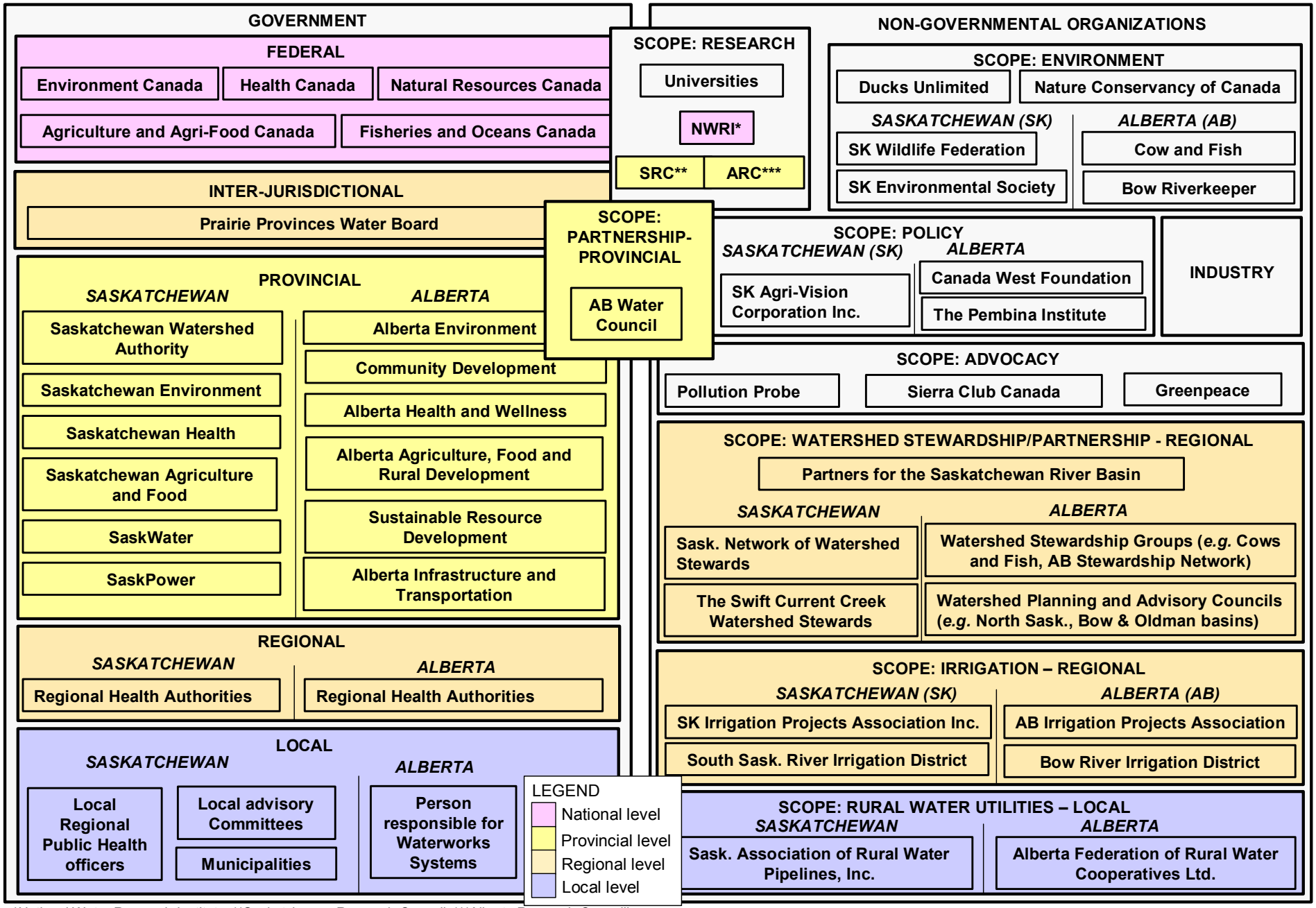
*Consensus approach, were provincial governments, as primary regulator pf water supplies, have always complied with the Agreement.

**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).

Some Important Institutions in the Saskatchewan Institutional Water Map, South Saskatchewan River Basin.

Derived by L. Patiño and D. Gauthier mainly from Corkal, D. R., Inch, B. and P.E. Atkins (AAFC-PFRA). 2007. The Case of Canada – Institutions and Water in the South Saskatchewan River Basin; and also from Hurlbert, Margot. 2006. Water Law in the South Saskatchewan River Basin. IACC Project working paper No. 27.



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

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.

FUTURE CLIMATE CHANGE SCENARIOS

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

Impact on water ↓

Water

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

Implications ↓

What would the possible implications be on current exposures and adaptive livelihood strategies under the above future climate change scenarios?

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.

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.

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

Production & income
-Majority of population is under gov. assistances ($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 jobs (only a handful of jobs)
-Hunt and fish to supplement food.
-Buy groceries in bulk –Engage in small and informal business

Blood Tribe Community

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 threatens 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 CONSTRAINS

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

Physical
Inadequate infrastructure (roads, Irrigation)

Economic
Land tenure 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.

Other sources: (a) Blood Tribe Administration Review. Tsinikssini VOL. 2 ISSUE 4 May- 07; VOL. 2 ISSUE 3 apr- 07; VOL. 2 ISSUE 2 FEB- 07; VOL. 2 issue 1 jan- 07. Online: http://www.bloodtribe.org/news/lands.pdf. Accessed: June 5th, 2007. (b) Blood Tribe Land Management Department. 2006. Blood Tribe Special Report. Published by Blood Tribe Administration Public Relations Dept. June 2006. Online: http://www.bloodtribe.org/news/lands.pdf. Accessed: June 5th, 2007. (c). Susan Lapp. Personal Communication June 2007. Research Fellow, PARC. (d) David Sauchyn. Personal Communication June 2007. Research Professor, PARC.

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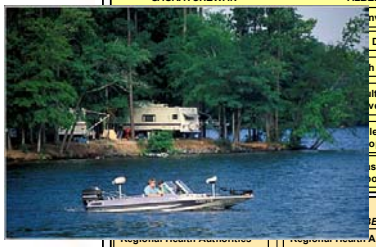

SCOPE: PARTNERSHIP-PROVINCIAL
AB Water Council
SCOPE: POLICY
SASKATCHEWAN (SK)
ALBERTA
SK Agri-Vision Corporation Inc.
Canada West Foundation
The Pembina Institute
INDUSTRY
SCOPE: ADVOCACY
Pollution Probe
Sierra Club Canada
Greenpeace
SCOPE: WATERSHED STEWARDSHIP/PARTNERSHIP - REGIONAL
Partners for the Saskatchewan River Basin
SASKATCHEWAN
ALBERTA
Sask. Network of Watershed Stewards
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: IRRIGATION – REGIONAL
SASKATCHEWAN (SK)
ALBERTA (AB)
SK Irrigation Projects Association Inc.
AB Irrigation Projects Association
South Sask. River Irrigation District
Bow River Irrigation District
SCOPE: RURAL WATER UTILITIES – LOCAL
SASKATCHEWAN
ALBERTA
Alberta Federation of Rural Water Cooperatives Ltd.
Prairie Provinces Water Board
Cow and Fish
Bow Riverkeeper
PROVINCIAL
LOCAL
Person responsible for Waterworks Systems
LEGEND
National level
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.
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Water
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• increase in flooding intensity and frequency (mainly in spring)
• increase in drought intensity and frequency (warmer longer summers)
Impact on water

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.

Warren, S. 2004. The utopian potential of GIS. *Carthographica* 39(1): 5- 16.

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.

Doug Aberley and Renee Sieber. 2002. Developed at First Interational PPGIS Conference held by URISA at Rutgers University, New Brunswick, New Jersey, July 20-22, 2002. Acceso:3 de mayo del 2006. http://ppgis.iapad.org/ppgis.htm

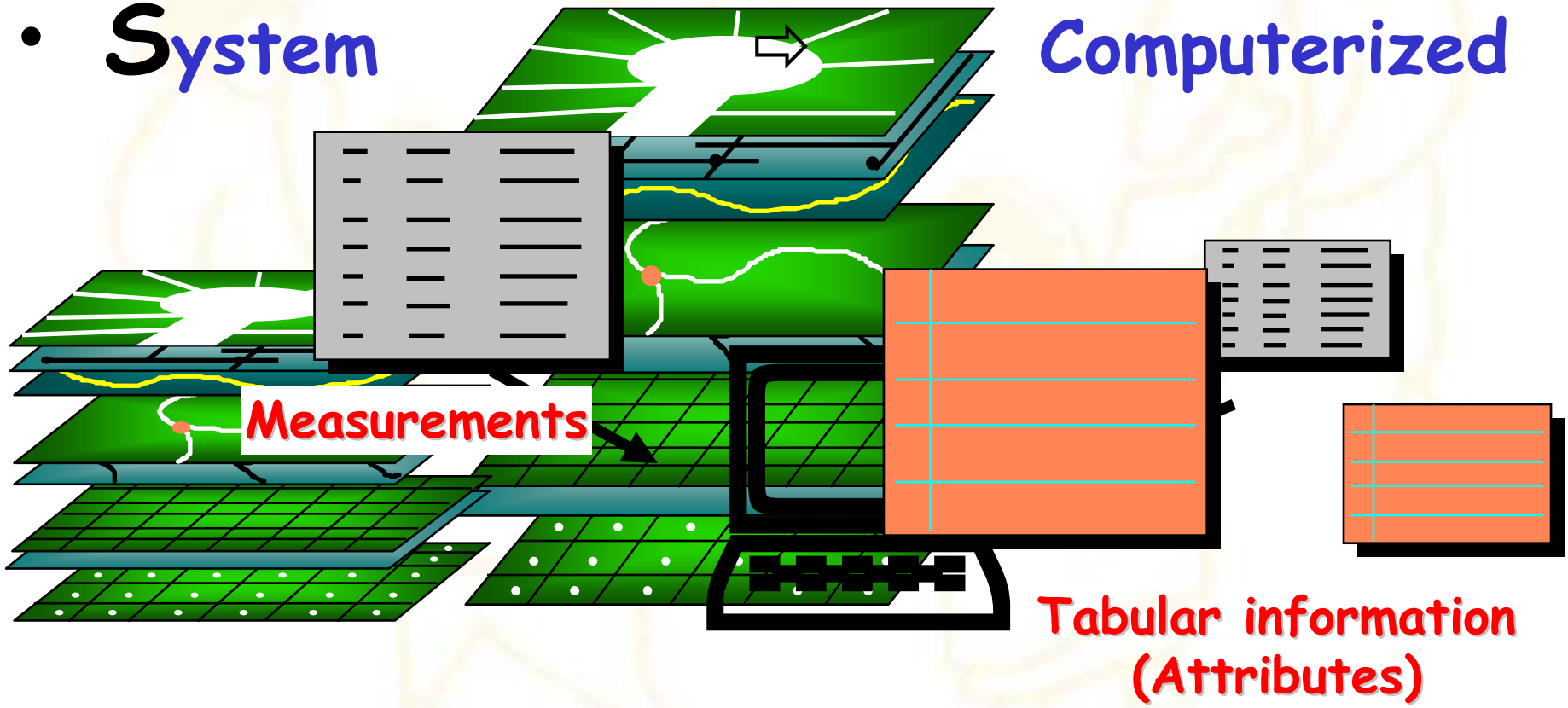
… continuation

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 ⇨ Map
- Information ⇨ Data
- System ⇨ Computerized

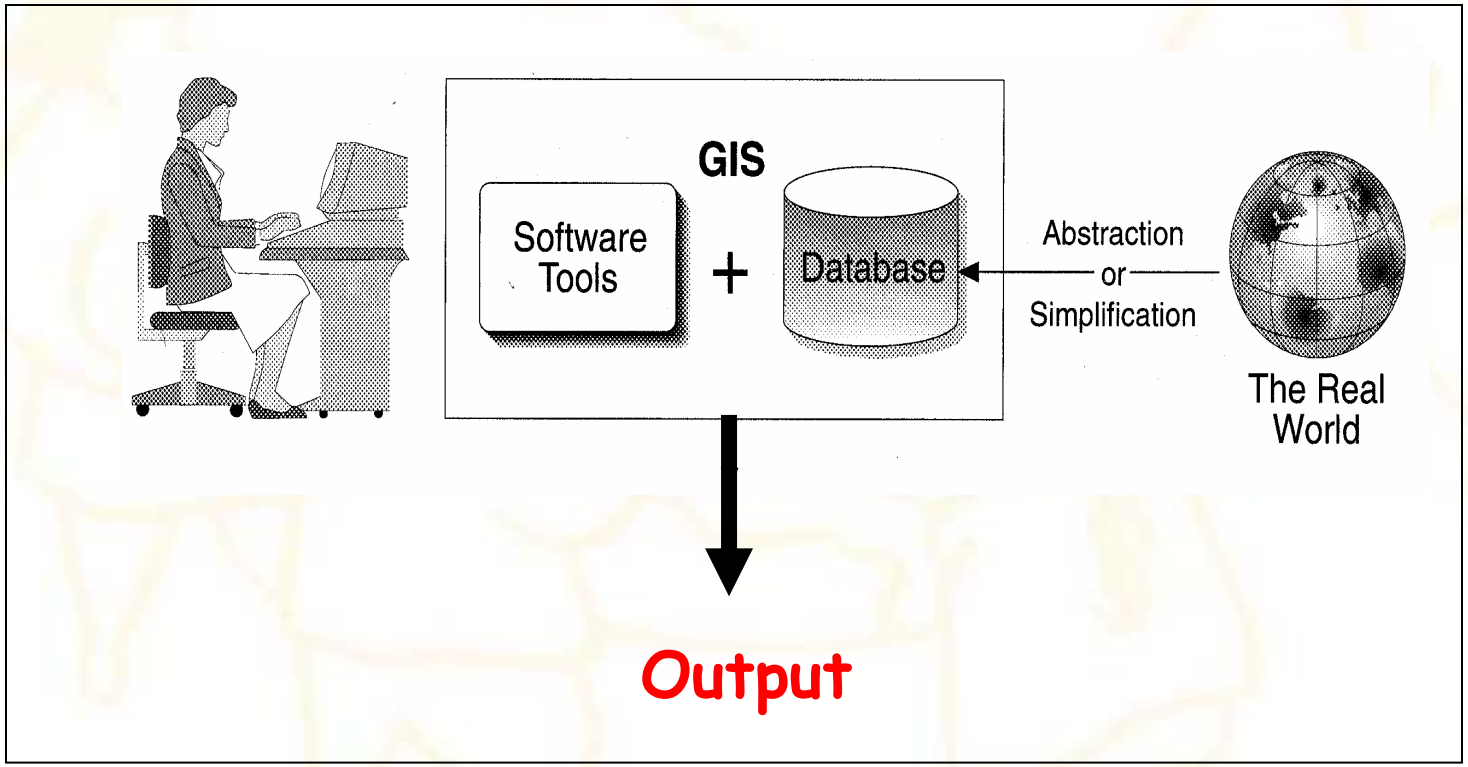


What is a Geographic Information Systems (GIS)?

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

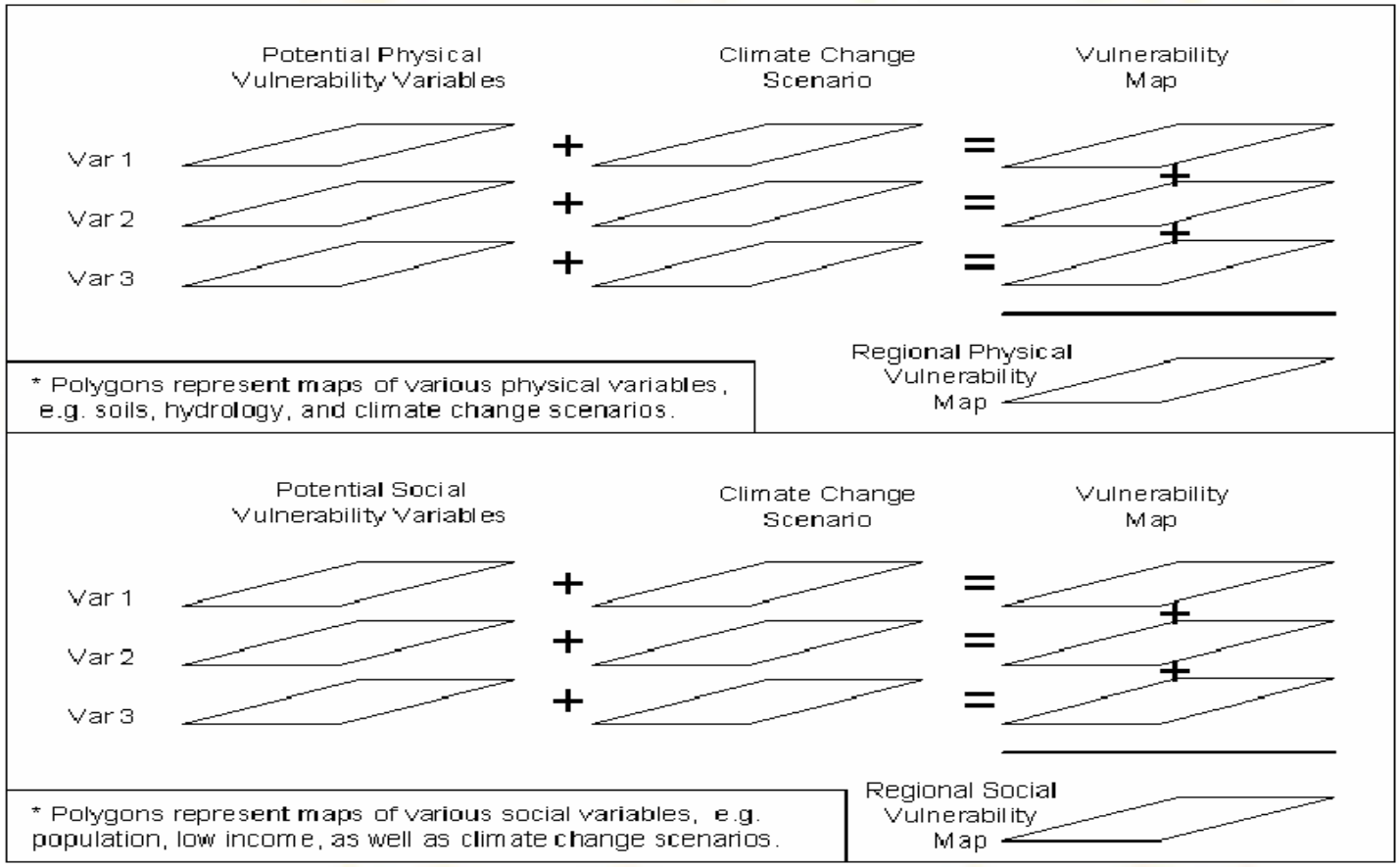
ESRI. 2007. What is GIS? Accessed: June 2007.Updated: April 4th, 2007. http://www.gis.com/whatisgis/index.html

Traditional components of a GIS



ESRI. 1994. Understanding GIS the ArcInfo Method. Version 7 for UNIX and Open VMS, Environmental Systems Research Institute, Redlands, California.

Traditional approach for the integration of information.

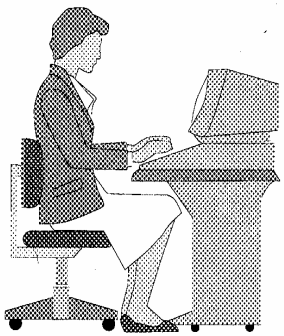


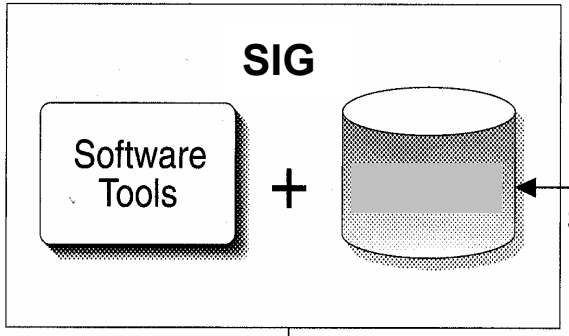
Biophysical information

+

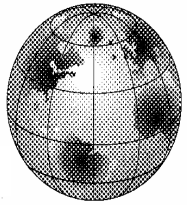
Socio-economic information

Diaz, H.P., D. Gauthier, D. Sauchyn, J. Cepeda, D. Corkal, M. Fiebig, S. Kulshreshtha, G. Marchildon, H. Morales, B. Morito, B. Reyes, A. Rojas, S. Salas, B. Smit, E. Wheaton, H. Zavala, 2004. Institutional Adaptation to Climate Change. Social Sciences and Humanities Research Council (SSHRC) Multi-collaborative Research Initiative (MCRI)

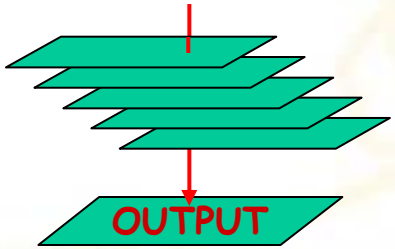




Abstraction
or
Simplificación

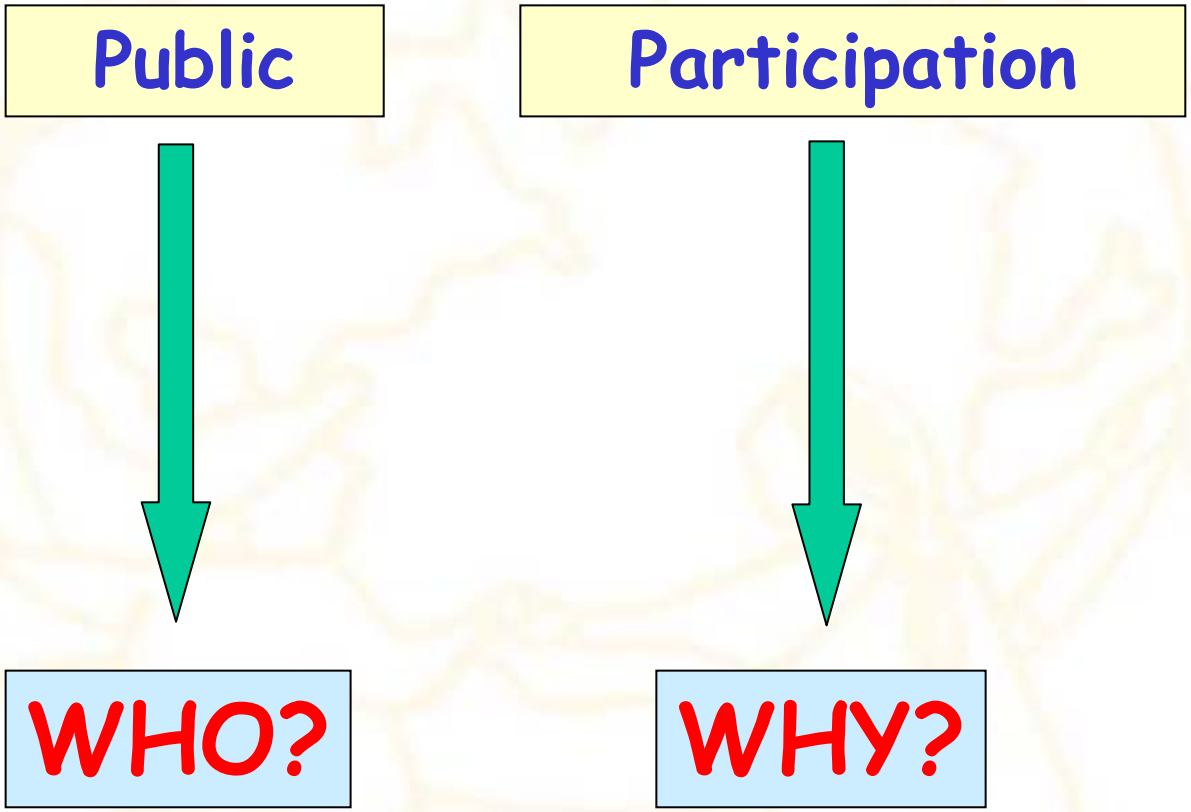


The Real World



Top-down

Public Participation (PP)

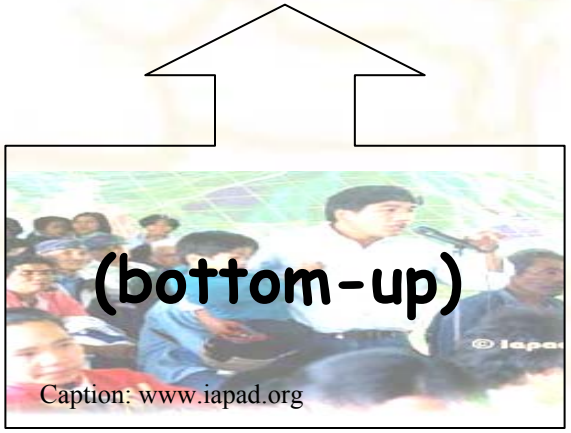


Public Participation

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.

Rahman, 1993 in Pimbert, 2004. Institutionalising participation and people-centered processes in natural resource management. Research and Publications highlights. IIED and IDS: London, United Kingdom.



Caption: www.iapad.org

"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).

Boothroyd, R., Fawcett, S., Stephen, B. &. Foster-Fishman, P. (2004). Community development: enhancing the knowledge base through participatory action research. (In L. Jason, C. Keys, Y. Suarez-Balcazar, R. Taylor & M. Davis (Eds.), Participatory community research: theories and methods in action (pp. 37-52). Washington D.C.: American Psychological Association)

Montero, M. (2004). Appendix B. New horizons for knowledge: the influence of citizen participation. (In L. Jason, C. Keys, Y. Suarez-Balcazar, R. Taylor & M. Davis (Eds.) Participatory community research: theories and methods in action (pp. 251-262). Washington D.C: American Psycological Association.)

Participation: scale of purposes

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

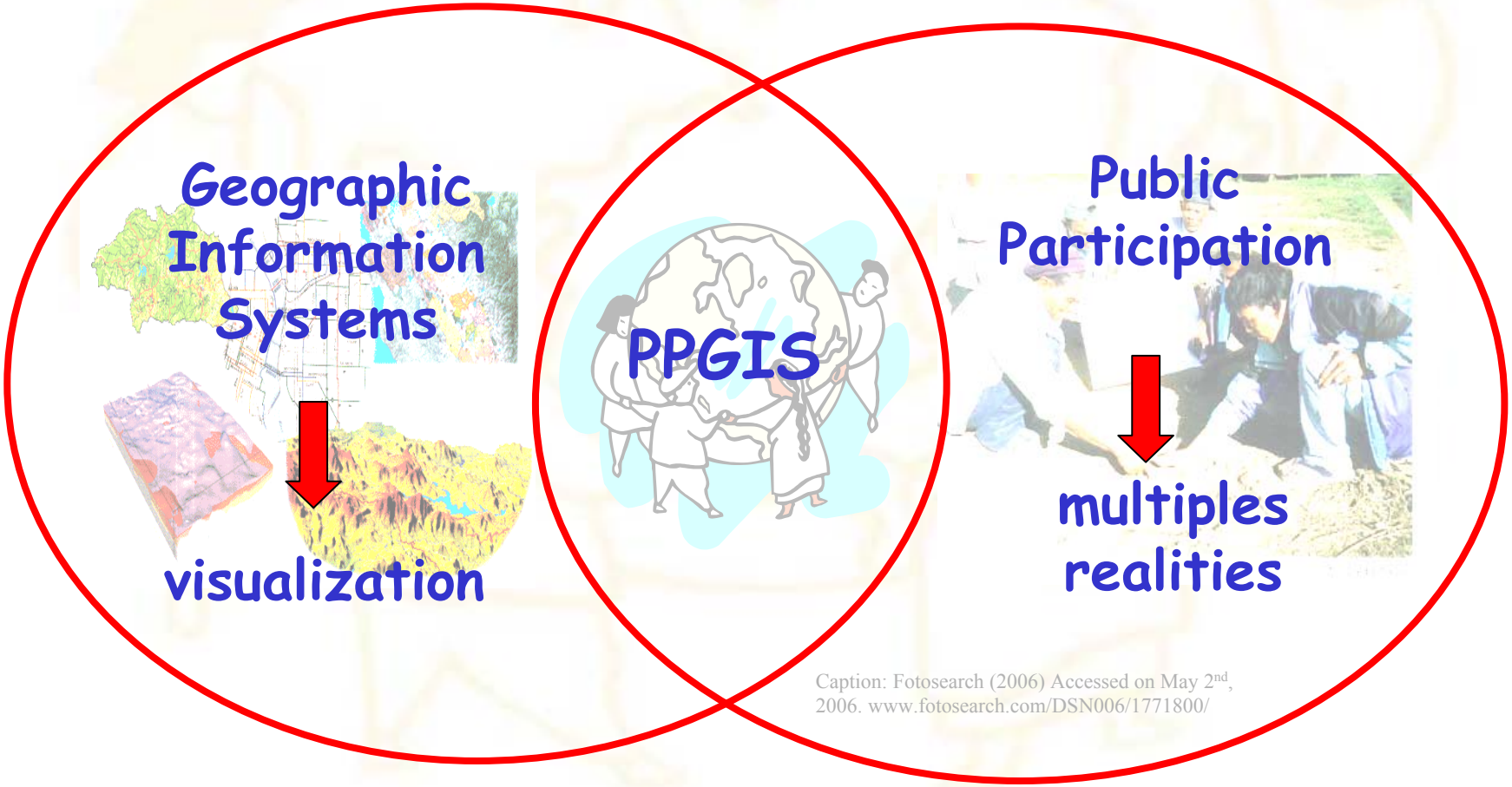
Expected Goals & Results

Concepts of Public

Author	*Dimension*	*Public Typology* *Focalized*	*Amorphous*
Aggens 	Energy and interest, time, and resources.	Decision-makers	→ Unsurprised apathetic
Mitchell et al. 	Power, legitimacy, and urgency	Definitive	→ Latent stakeholders
Thomas	Organizational complexity	One group	→ Complex group
		Public selection	
Willeke	Relevant public	Self-selection	→ third part
Creighton	Affected public	Spatial proximity	→ values alignment

Schlossberg and Shuford. 2005. Delineating "Public" and "Participation" in PPGIS. *URISA Journal* **16**(2), 15-26.

PPGIS
Public Participatory Geographic Information Systems



Caption: Fotosearch (2006) Accessed on May 2nd, 2006. www.fotosearch.com/DSN006/1771800/

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Hard sciences
Objectivity
Quantitative
Generalities

Expert knowledge

top-down approach

INFORMED

INTEGRATION

PROCESS

VALUES AND PERCEPTIONS

bottom-up approach

Local knowledge

Social sciences
Subjective
Qualitative
Contextual (local)

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

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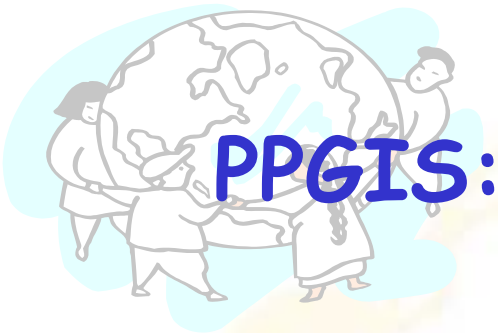

PPGIS: Reflective and an informed interactive process

Integration of values and perception;
Empowerment;
Collaboration institutions;
Social learning;
Social capital;
Human capital.

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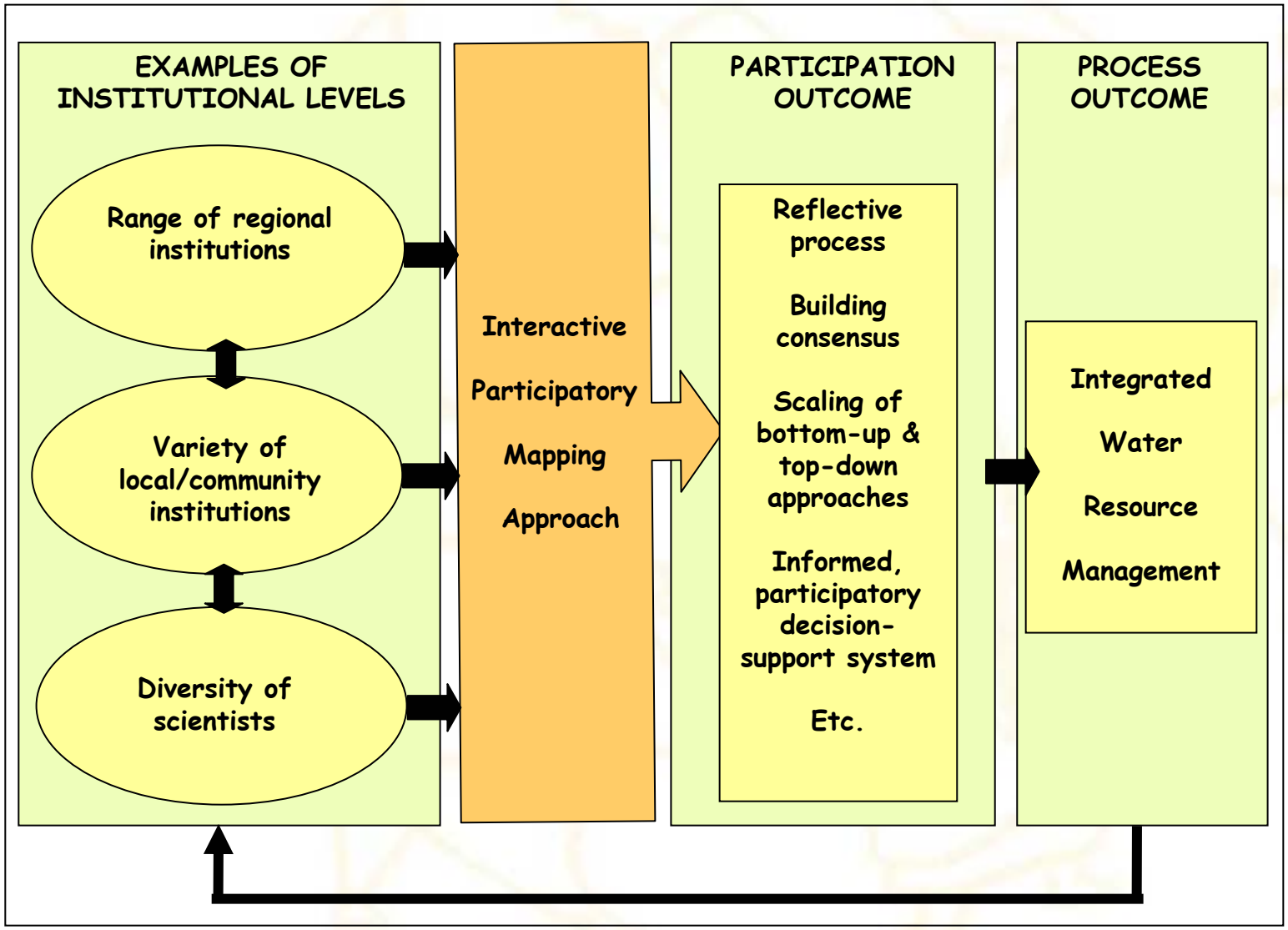
PPGIS model for integrating multiple realities of water resource management.



Adapted from: Patiño and Gauthier (2006). Modeling institutional vulnerability and adaptation to climate change using participatory mapping techniques.

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.

FUTURE CLIMATE CHANGE SCENARIOS

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

Impact on water ↓

Water

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

Implications ↓

What would the possible implications be on current exposures and adaptive livelihood strategies under the above future climate change scenarios?

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.

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.

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

Production & income
-Majority of population is under gov. assistances ($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 jobs (only a handful of jobs)
-Hunt and fish to supplement food.
-Buy groceries in bulk –Engage in small and informal business

Blood Tribe Community

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 threatens 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 CONSTRAINS

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

Physical
Inadequate infrastructure (roads, Irrigation)

Economic
Land tenure 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.

Other sources: (a) Blood Tribe Administration Review. Tsinikssini VOL. 2 ISSUE 4 May- 07; VOL. 2 ISSUE 3 apr- 07; VOL. 2 ISSUE 2 FEB- 07; VOL. 2 issue 1 jan- 07. Online: http://www.bloodtribe.org/news/lands.pdf. Accessed: June 5th, 2007. (b) Blood Tribe Land Management Department. 2006. Blood Tribe Special Report. Published by Blood Tribe Administration Public Relations Dept. June 2006. Online: http://www.bloodtribe.org/news/lands.pdf. Accessed: June 5th, 2007. (c). Susan Lapp. Personal Communication June 2007. Research Fellow, PARC. (d) David Sauchyn. Personal Communication June 2007. Research Professor, PARC.

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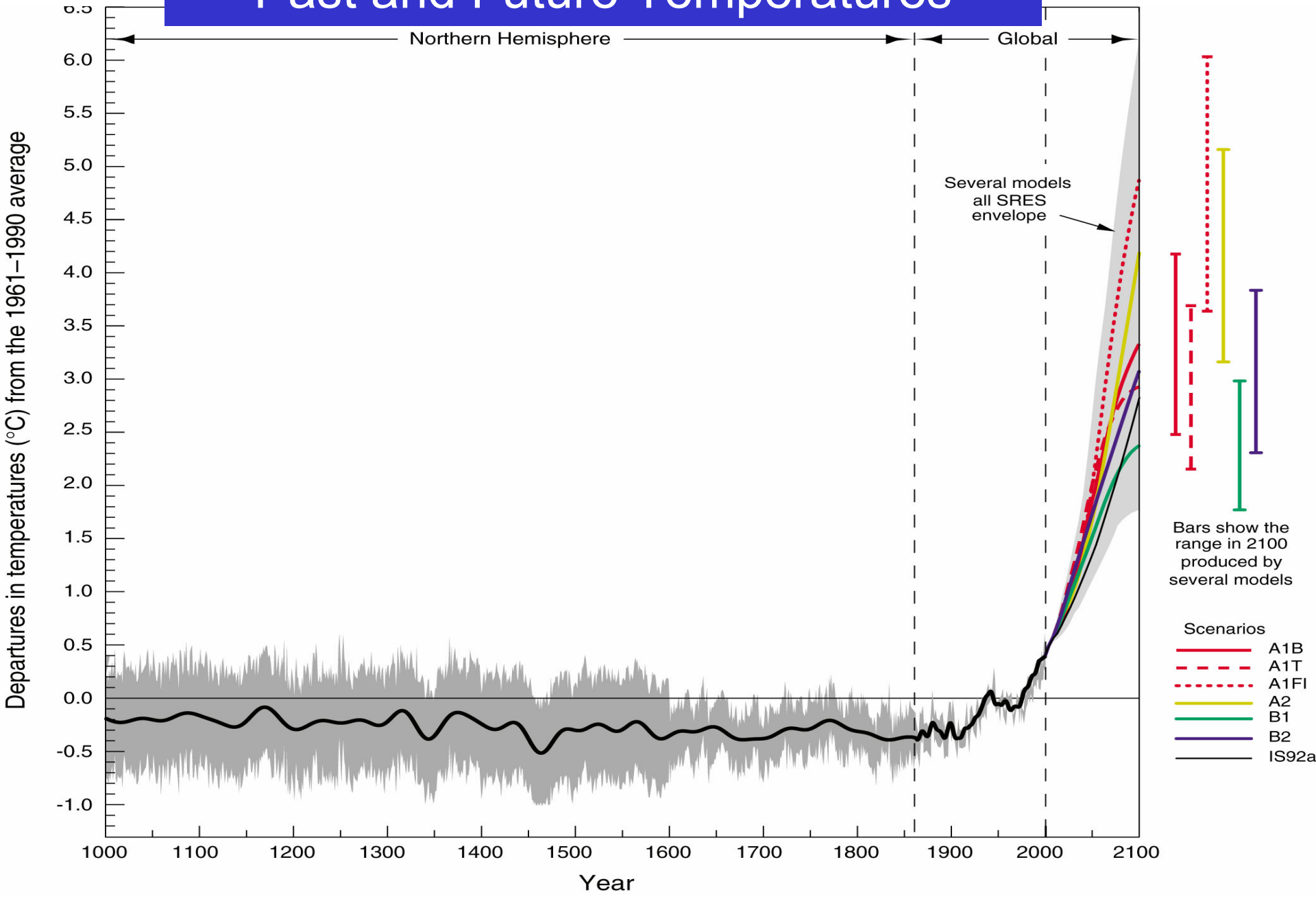
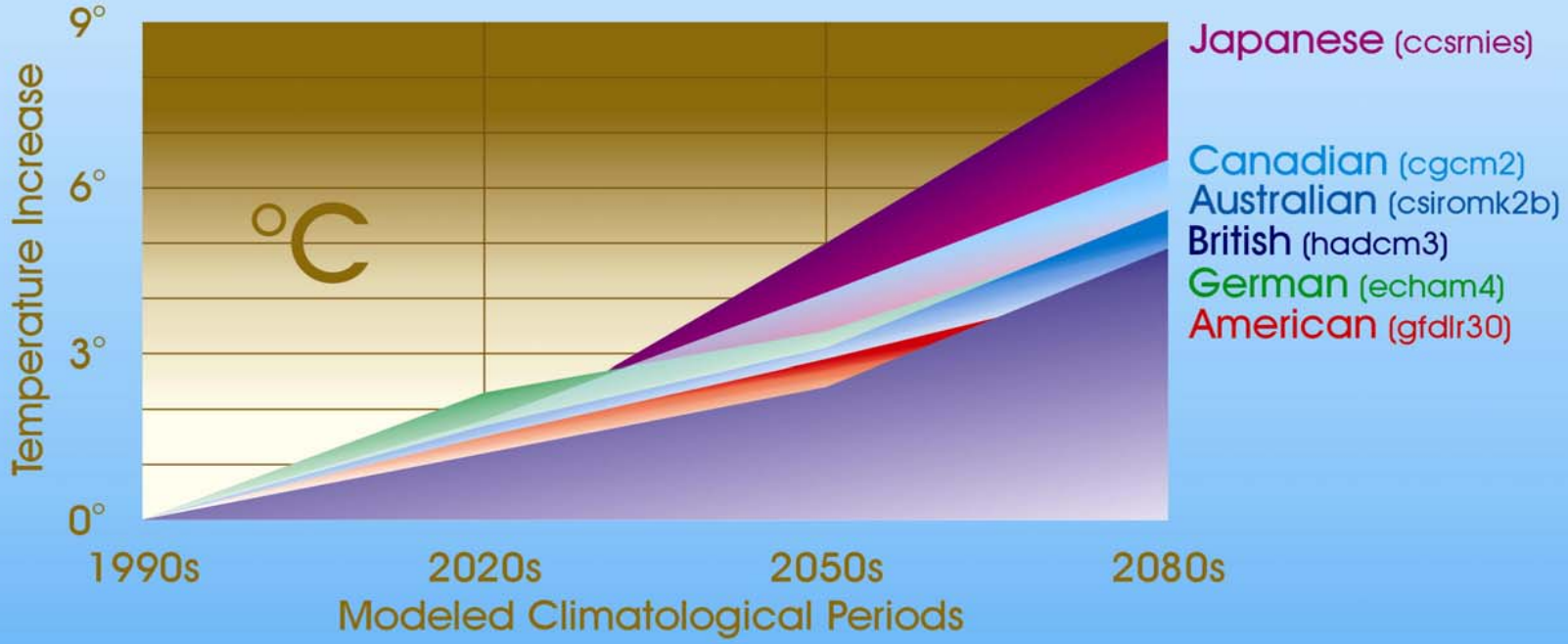
Past and Future Temperatures

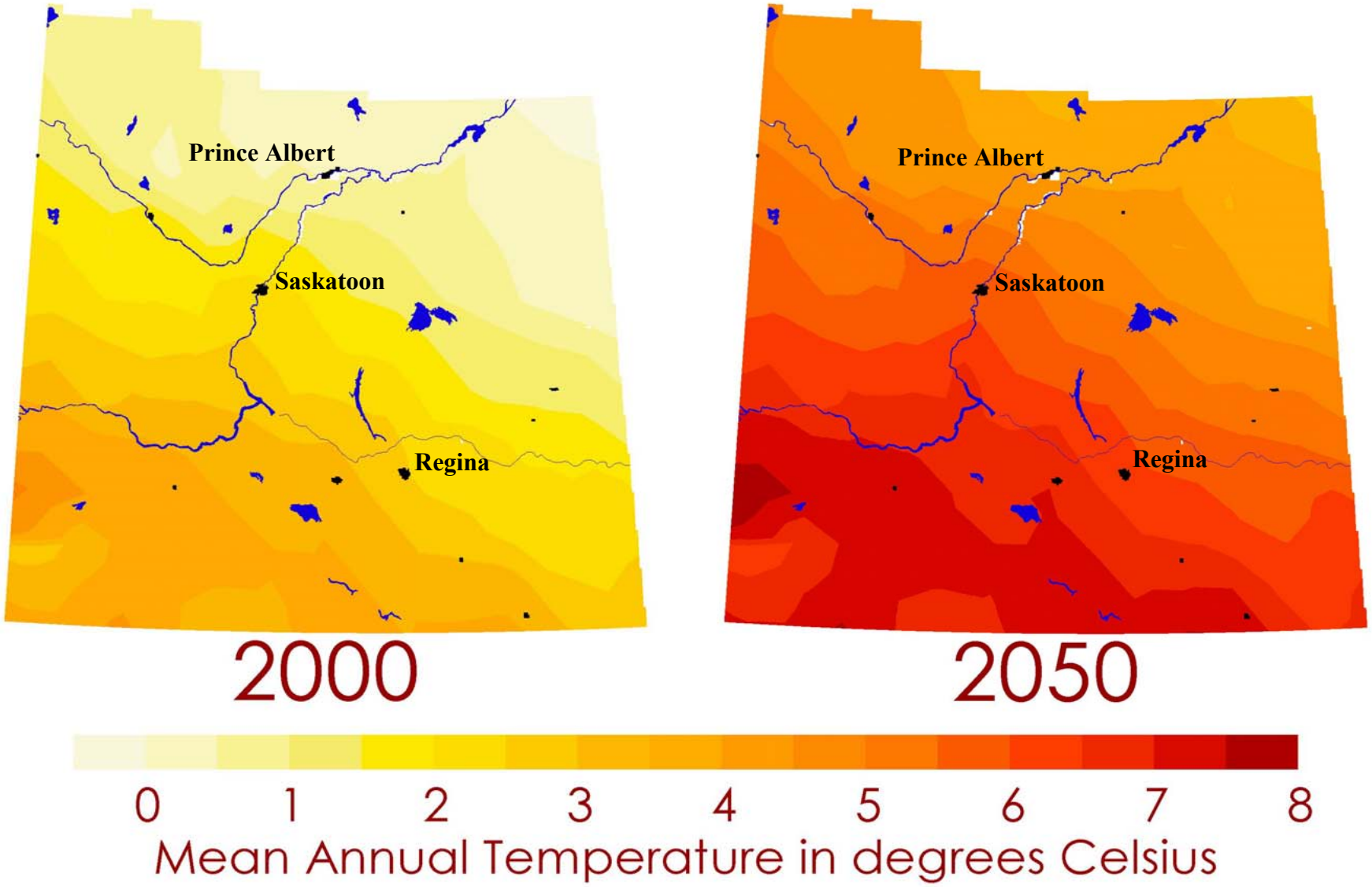




Comparison of Six Global Climate Models...

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....

Desiccating Grassland southeast of Val Marie in southwestern Saskatchewan.
—photo: Jeanette Pepper