

Université libre de Bruxelles
Brussels, Belgium
January 23, 2015

Developing hydro power decision aid on projet prioritizing applying Visual PROMETHEE – Case study from Nepal

Rana Pratap Singh
BOKU, Vienna

2nd International MCDA Workshop on
PROMETHEE: Research and Case Studies



Organization of the Presentation:

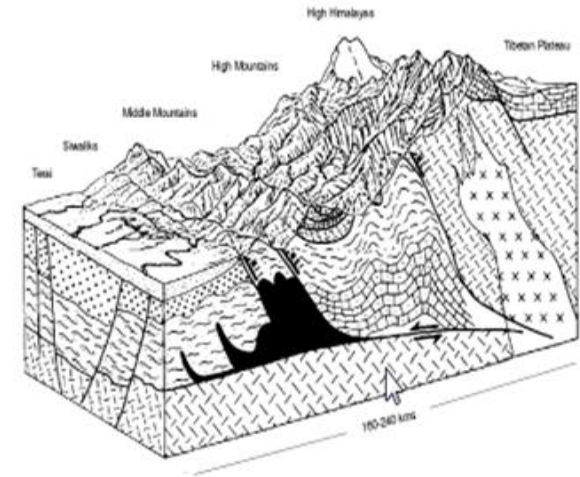
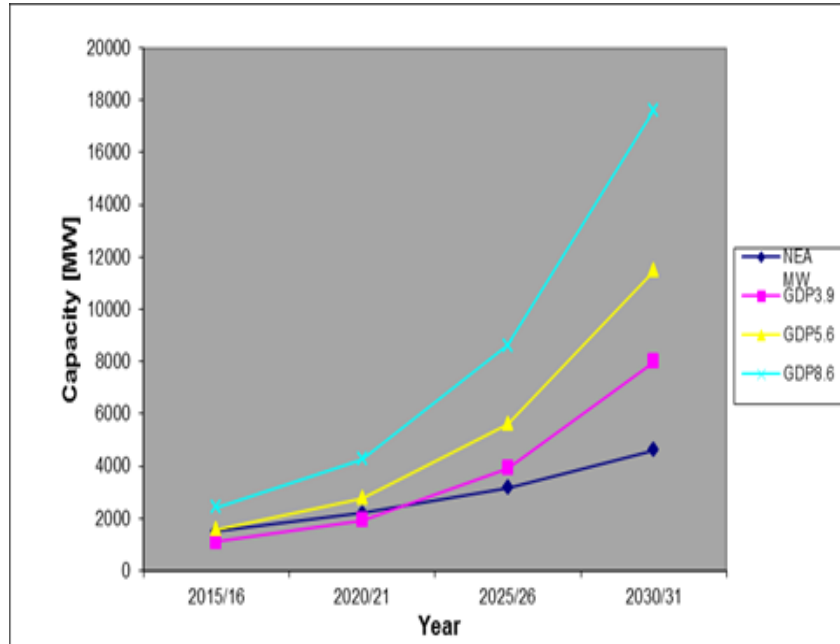
Introduction

- Country context
- Objective of the research (Hydropower Decision aid)
- Over all study:
 - * Perspective analysis,
 - * AHP applications
 1. *Secondary information based*
 2. *Questionnaire based*
 - *Visual PROMETHEE application on hydropower decision aid development
- **PROMETHEE**
 - Criteria identification
 - findings and
 - results
- **Frame work developed**



Country context:

Energy situation



Hydropower is major source to meet energy need

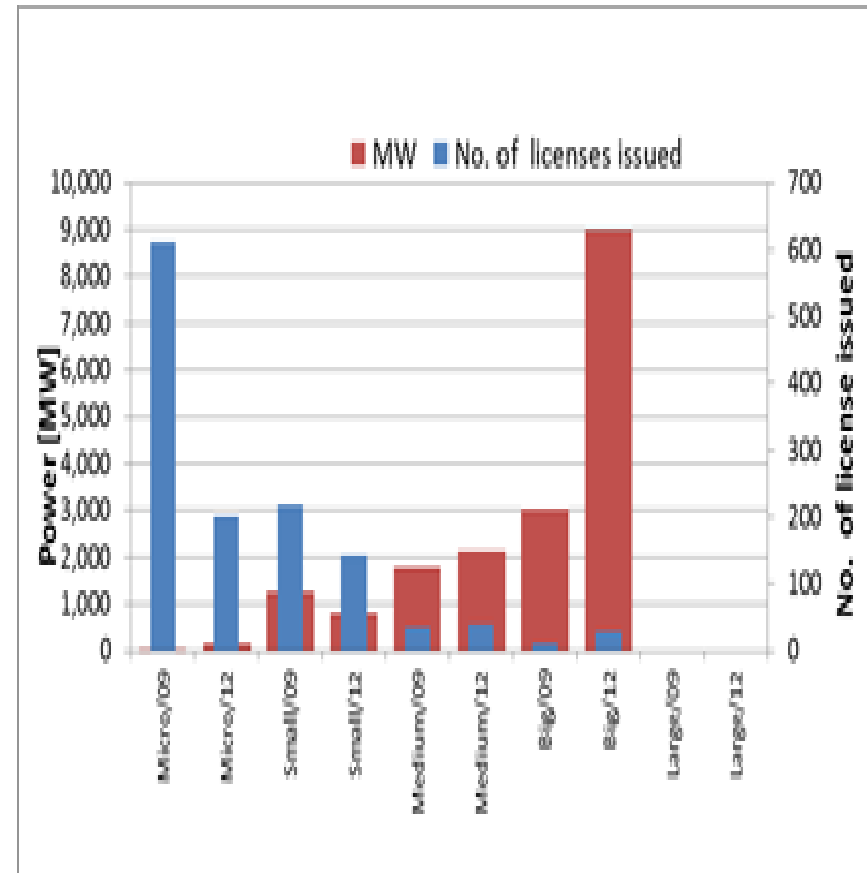
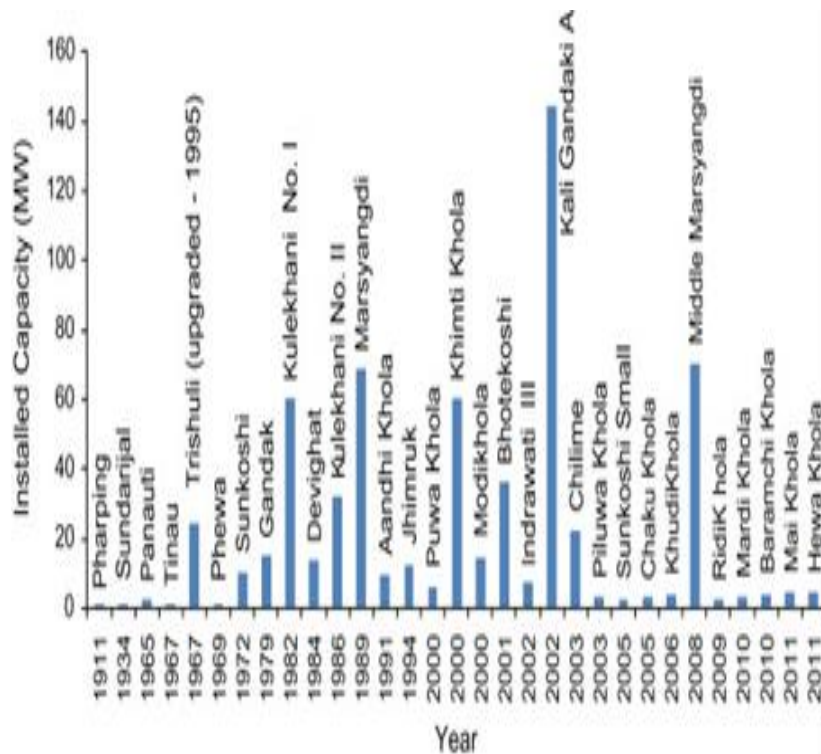
Country context:

Potential: 83,000 MW (400,000 MW) , River basins



Country context:

- Hydropower progress
- Micro to Large schemes- 5 classes



Objective:

Issues: Not sustainable, facing technical, social, environmental and economical challenges

Decision practice: Ad hoc, CBA,
Political Vs **MCDA intervening in
decision making**

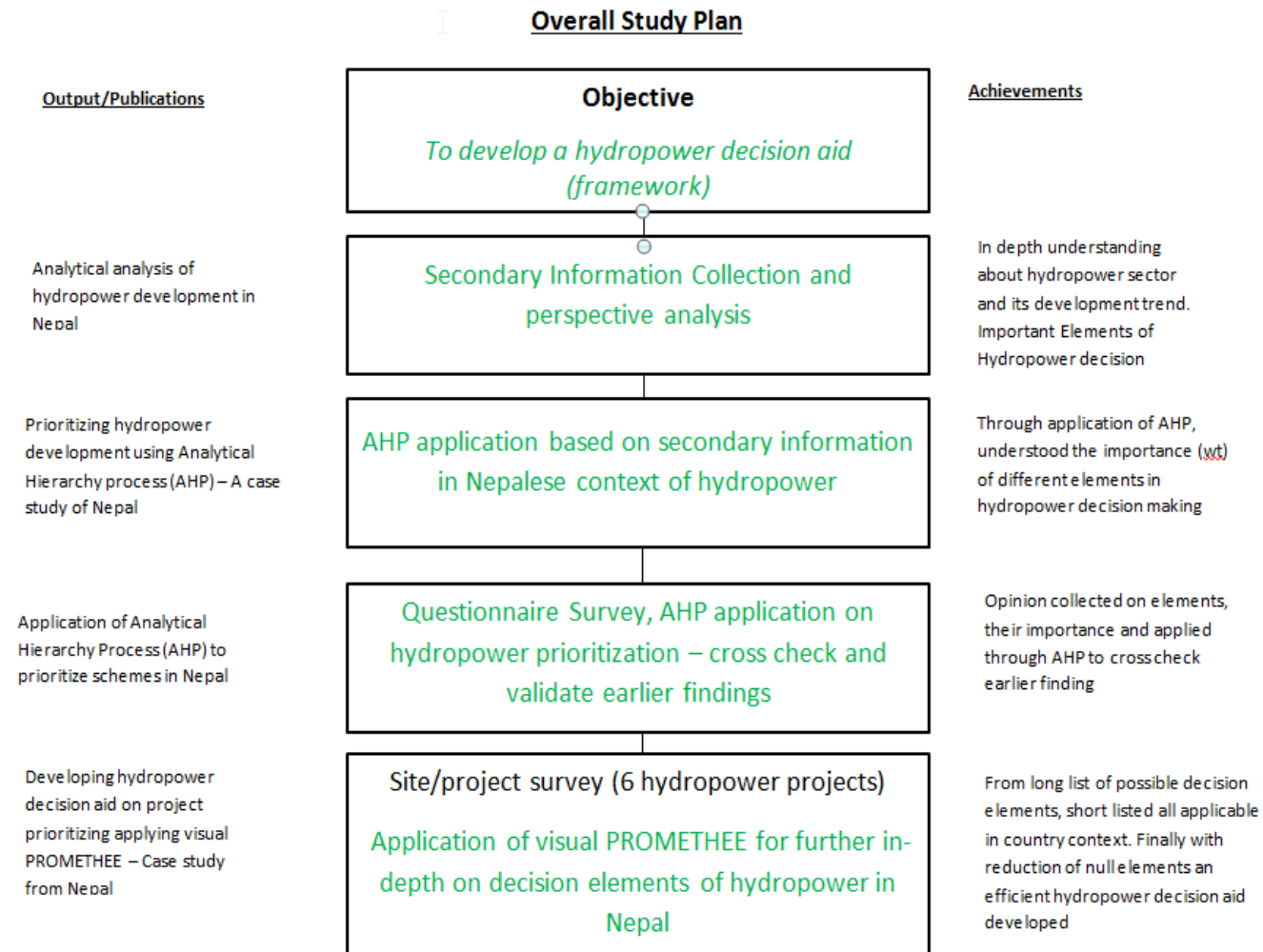
- **Objective:**

- Develop decision aid (frame work) appropriate in Nepalese context



Study plan:

Perspective analysis:



Results from studies and challenges remaining to achieve objective:

Perspective analysis

Results:

Priority order found is Medium, Big, Small, Micro and Large Hydropower schemes

Challenge:

Simple scoring – no appropriate weightage

Recommendations:

Further analysis based on Multi Criteria Decision Analysis (MCDA) using scientific tools like Hierarchy Process (AHP), PROMETHE, ELECTRE

AHP secondary:

Results

Priority order found is Medium, Big, Small, Micro and Large Hydropower schemes

Challenge:

Weight assigned at top level is based on secondary information (??) while pairwise comparison generate weight at mid and bottom Level- Cross check the results so far

Recommendations:

Further cross check through questionnaire survey, workshop or expert opinion is highly recommended.

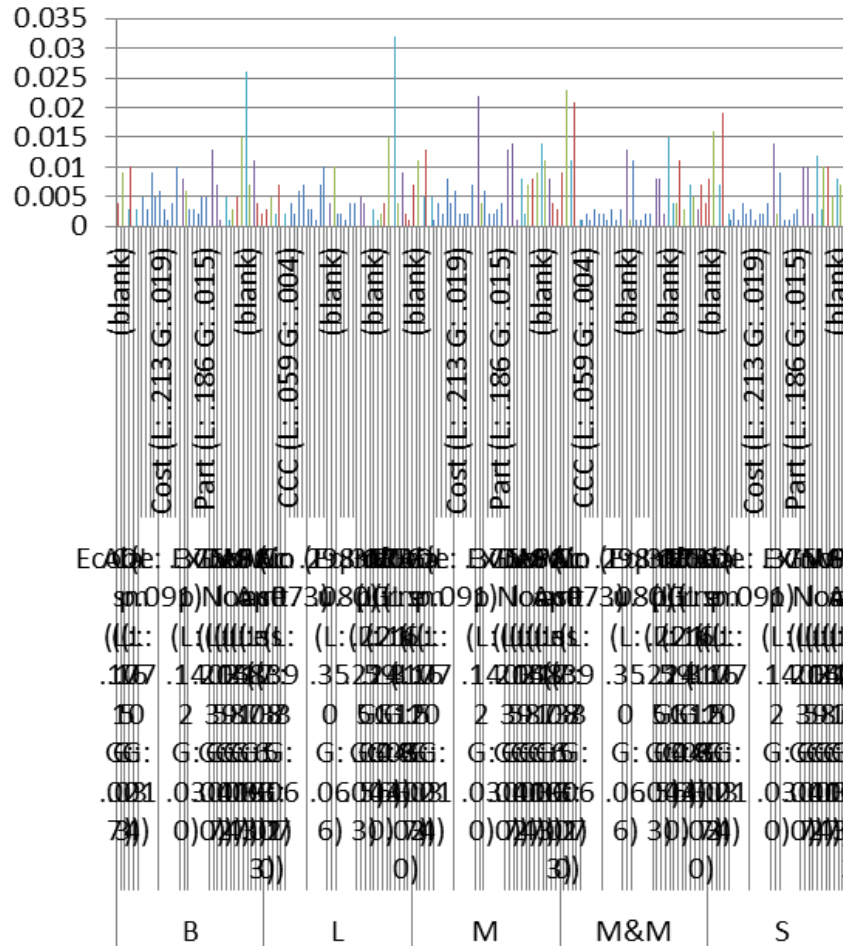
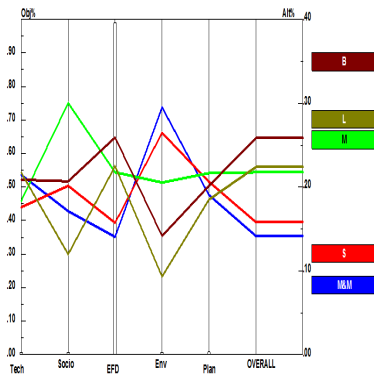
Results from studies and challenges remaining to achieve objective:

- AHP Questionnaire survey

Explore relative positions of elements and details on sub elements for further insight in decision making

Handling capacity (numbers) of factors, alternatives and pairwise comparisons

Performance Sensitivity for nodes below: Goal: Select appropriate scale of Hydropower



- EFD (L: .244 G: .244)
- Env (L: .155 G: .155)
- Plan (L: .210 G: .210)
- Socio (L: .189 G: .189)
- Tech (L: .201 G: .201)

PROMETHEE:

Scope:

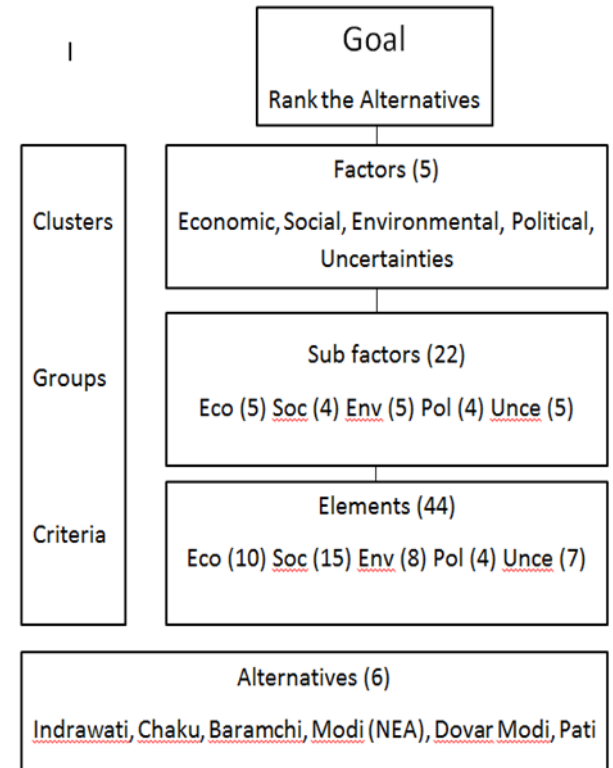
- identify various factors and sub factors
- establish priority basis while valuing criteria
- develop decision framework (format)

Issues:

Set of criteria and corresponding weight

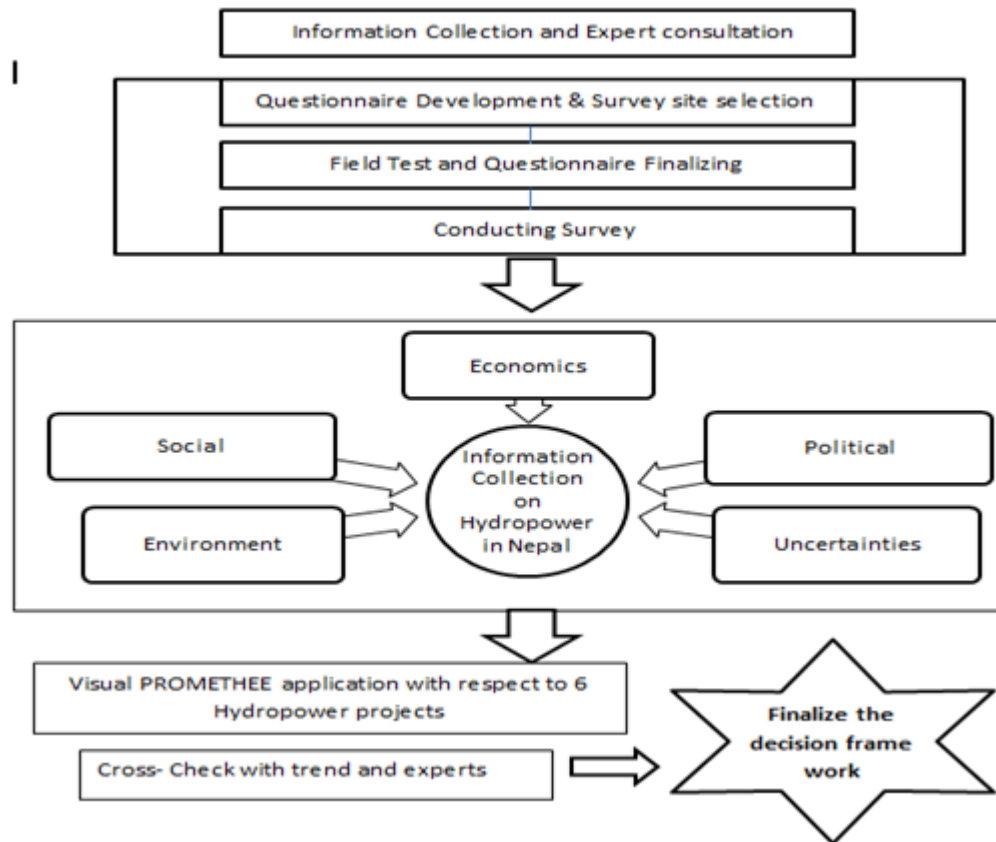
Beneficiaries:

Stakeholders, planners, decision makers and researchers



PROMETHEE:

Methodology:



Plants studied:



S.N.	Name of Scheme	Capacity MW	Location District	Owner	Year Comp.	Cost (2013) \$/kW
1	Chaku Khola	1.5	Sindhupalchowk	Alliance Power Nepal, Pvt. Ltd.	2005	3452 BPI
2	Indrawati	7.5	Sindhupalchowk	National Hydropower Company	2002	3442 BPI
3	Baramchi	4.2	Sindhupalchowk	Unique / Hydro Solutions	2010	2222 Adj.
4	Modi (NEA)	14.8	Parbat	Nepal Electricity Authority	2000	2734 BPI
5	Modi lower	10	Parbat	United Modi Hydropower Pvt. Ltd.	2013	2342 Adj
6	Pati	1	Parbat	Unified Hydropower Pvt. Ltd.	2006	2330 Adj

Criteria listing:

Criteria (5)	Sub criteria (23)	Elements (44), symbol and description
Economic	Power Capacity	PG=Yearly power generation
	Benefits	LF= Local infrastructure developed due to project FC= Flood control effect reached IF= Irrigation facilitated FD= Fishery developed
	Cost	Cost (C)= Total cost of project investment
	Employment	ST= Directly related to project- short term LT= Directly related to project – long term
	Use of local resources	SB= Indirectly related to project- secondary benefit UL= Available local resources and materials
Social	Equity and Benefits	Equ (EB)= Distribution, both cost (risk) and benefits Gen main (GM)= Gender main streaming, inclusiveness Lively (OL)= Opportunities strengthening livelihood
	Project induced impacts	PR= Power reliability and grid integration Mov (MA)= Movement: HH activities (farming, grazing) LO= Impact on law and order and local life style Re (RO)= Recreation opportunities: HS= Heath Safety: Effect on human DR= Displacement and resettlement of PAF MTL(MT)= Minorities maintaining traditional life style: CH= Effects on cultural heritage, earlier settlements
	Transparency and Governance	Vis (CV)= Project to make the community visible PP = Public participation in Decision Making: PMG (PM)= Partnerships in management/governance
	Technology-knowhow and social capital	TK= Local people trained & social capital enhanced
Environmental	Degradation due to HPP	FL= Forest and biodiversity loss FLE (FE)= Area of farmland expropriated
	Sediment balance	SB= Tapping of sediment- riverbed scouring
	Impact on water resources	WQ= Water quality WA= Water availability WC= Impact of water natural connectivity
	Solid waste and pollution	SPW (SW)= Solid waste, noise and vibration and also proper monitoring during construction
	Visual impact	VI= On landscape due to project
Political	Contribution to national independence	NI= Project could support the independency
	Conflict and impact to other countries	CION (IC)= International conflict (due to project):
	Sector priority and PPP	SP= Power plant is as per the govt. preference.
	Regional balance	RB= Supporting regional balance of generation
Uncertainty	Technological risk	TR= Hydrological, geological and seismic risk.
	Political (regulatory) risk	PR = Change in policy & priorities is political risk
	Environmental risk	ER= Climate change, greenhouse, land/rock--
	Implementation risk	IR= Institutional risk: SR= Social risk: CR= Coordination risk:
	Marketing and financing risk	MR= Change in market demand, competition & capital financing scenarios.



PROMETHEE findings:

Visual PROMETHEE Academic - Rana 6 sites all elements experiment1.vpg (saved)

File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help

The interface displays several key components:

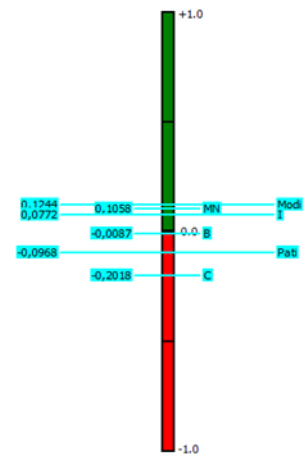
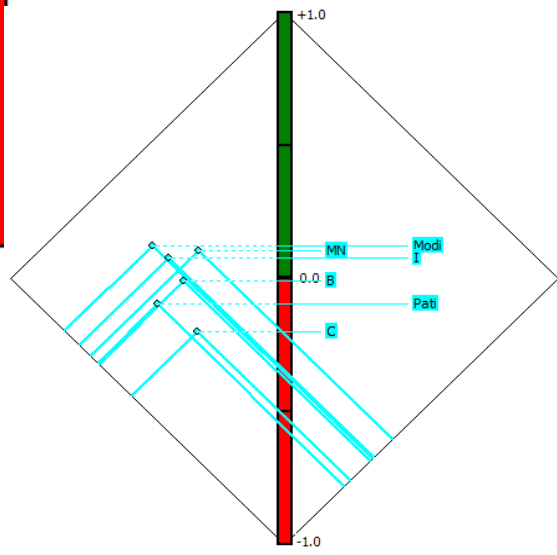
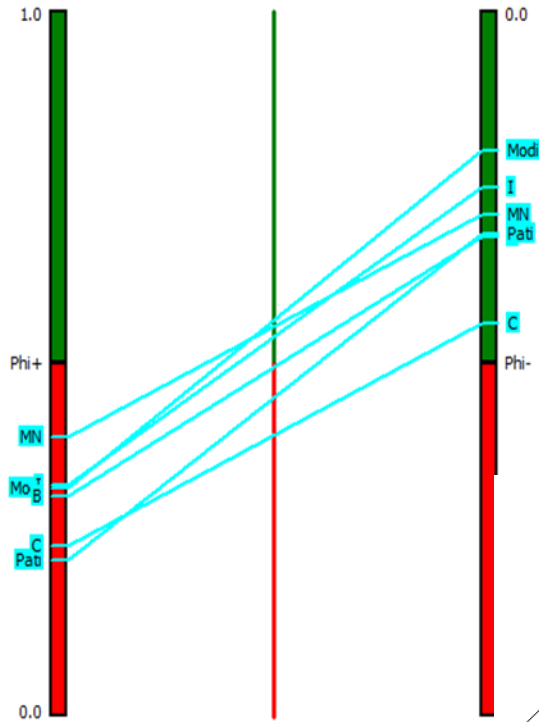
- Preferences Table:** A table with columns for various criteria (RPS, PG, LF, FC, IF, FD, Cost, ST, LT, SB, UL, Equ, Gen main, Lively, PR) and rows for Unit, Cluster/Group, Min/Max, Weight, Preference Fn., Thresholds, and Statistics.
- Statistics Table:** A table showing statistical data for each criterion, including Minimum, Maximum, Average, and Standard Dev.
- Evaluations Table:** A table showing evaluation results for each criterion, with columns for Pab, Modi, MN, B, I, and C.
- PROMETHEE Rainbow:** A visualization window showing a rainbow-colored bar chart for each criterion, with labels for various elements (e.g., Gen main, PR, LF, FC, ST, LT, SB, UL, Equ, Gen main, Lively, PR).

Criteria	RPS	PG	LF	FC	IF	FD	Cost	ST	LT	SB	UL	Equ	Gen main	Lively	PR
Unit	kw	5-point	5-point	5-point	5-point	5-point	US\$/kW	5-point	5-point	5-point	5-point	5-point	5-point	5-point	5-point
Cluster/Group															
Min/Max	max	max	max	max	max	max	min	max	max	max	max	max	max	max	max
Weight	8,40	3,19	0,00	3,19	1,74	8,13	3,19	3,19	3,76	0,00	4,15	3,19	0,00	2,00	
Preference Fn.	Linear	Usual	Usual	Usual	Usual	Linear	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
-Q: Indifference	25	n/a	n/a	n/a	n/a	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
-P: Preference	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
-S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minimum	996	3,00													
Maximum	14800	4,00													
Average	6499	3,67													
Standard Dev.	4877	0,47													
Pab	996	average													
Modi	10000	good													
MN	14800	good													
B	4200	good													
I	7500	good													
C	1500	average													

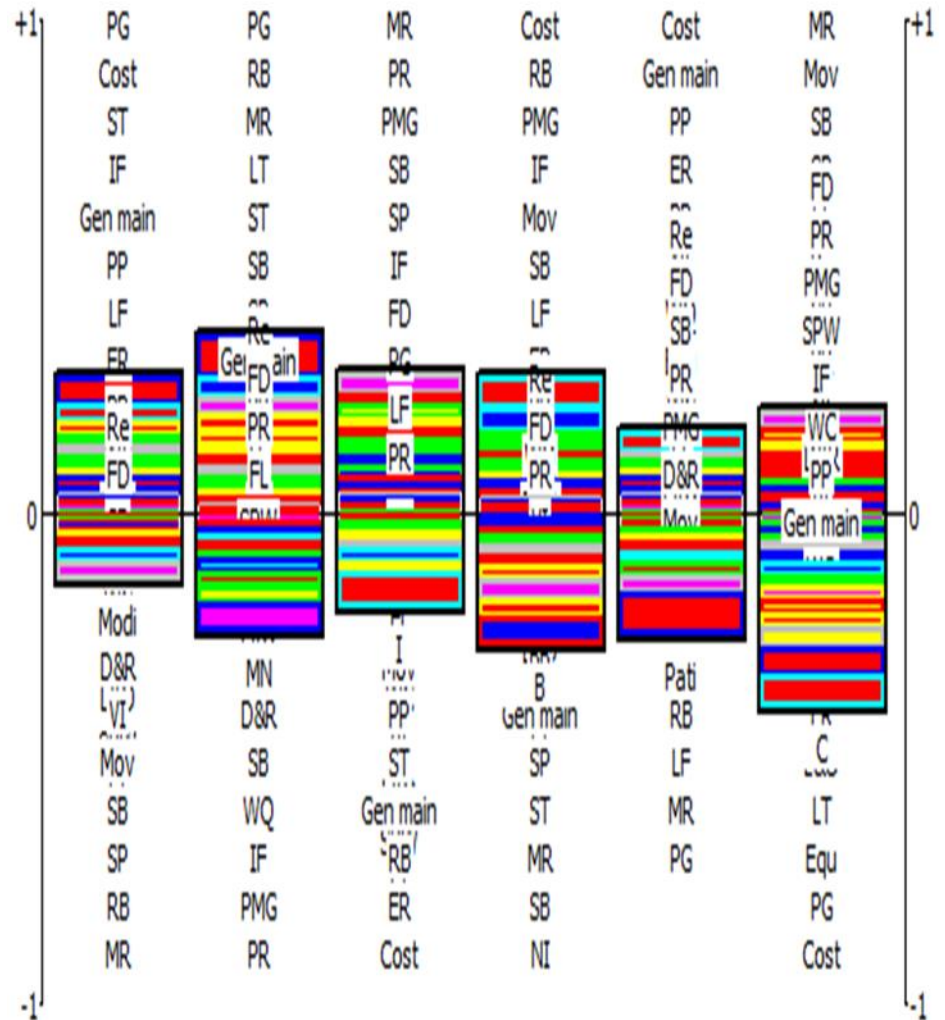
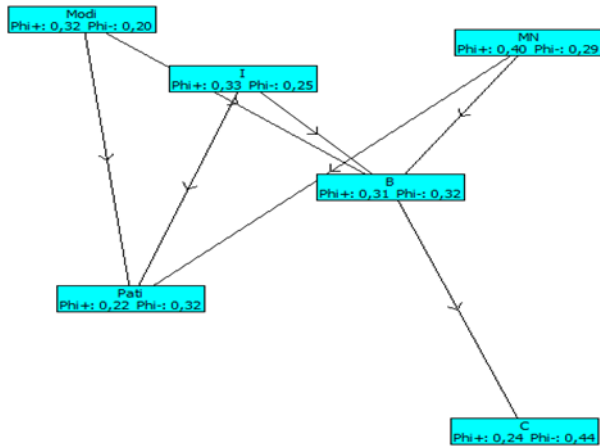
Actions: 6 (6 active) Criteria: 44 (44 active) Scenarios: 1 (1 active) Locale: Custom [NR/] Saved

7:57 AM 6/2/2014

PROMETHEE findings:

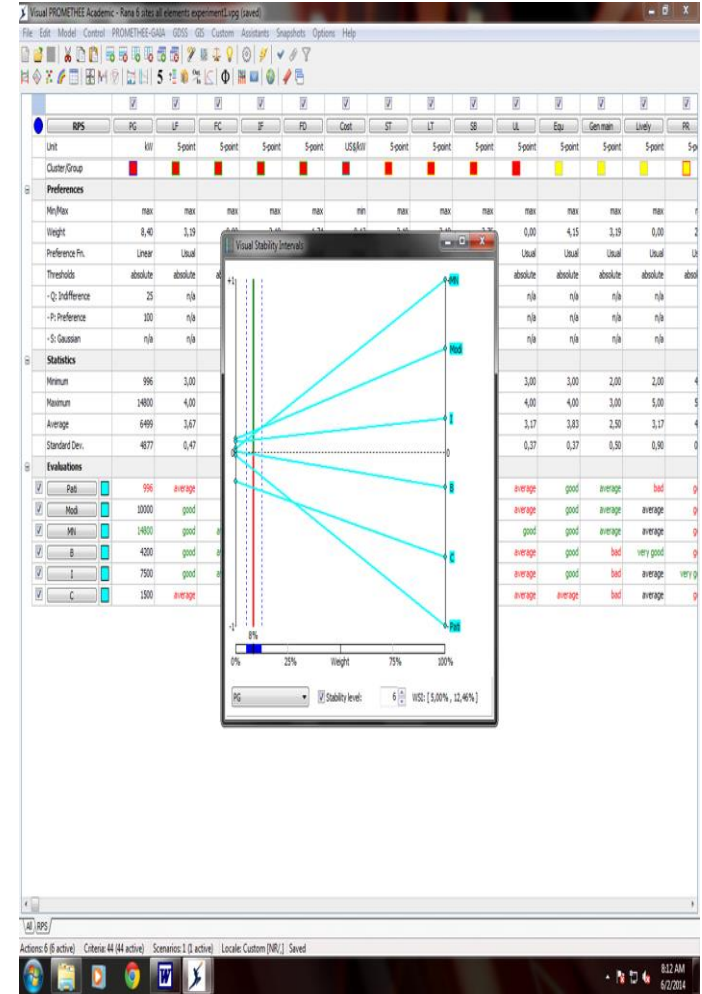
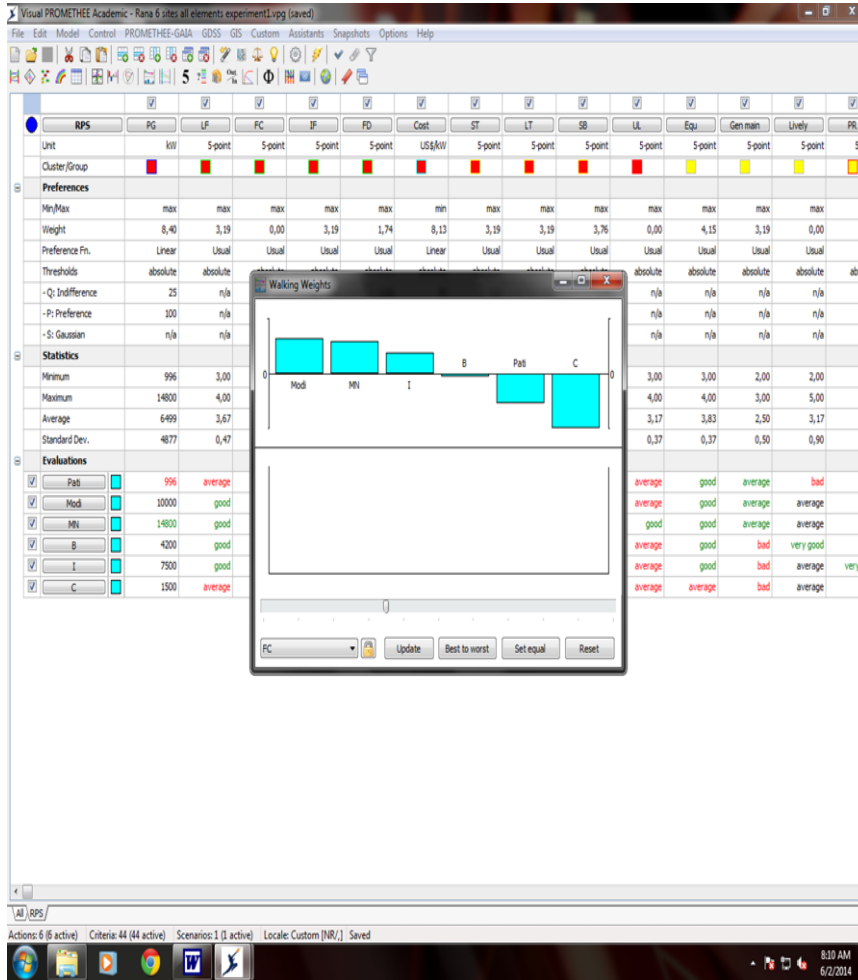


PROMETHEE findings:

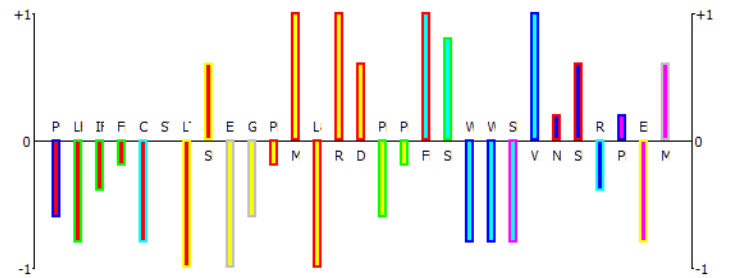
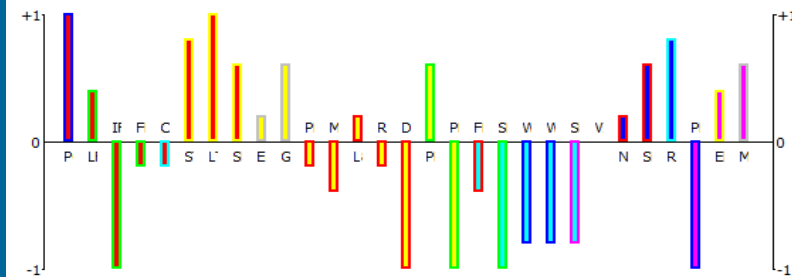
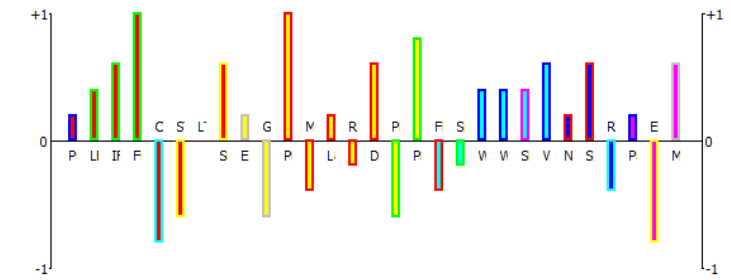
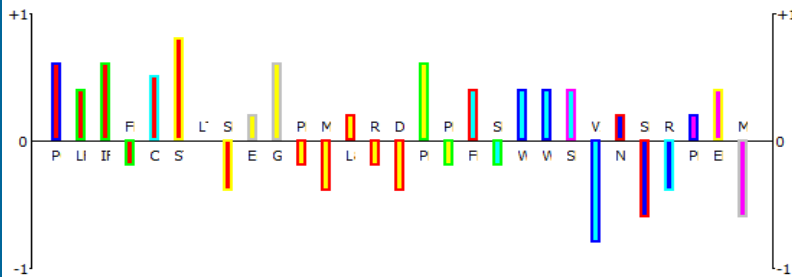
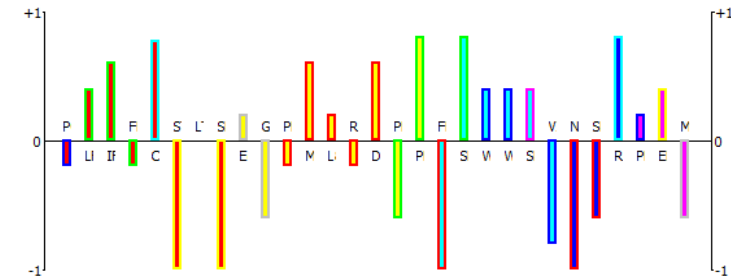
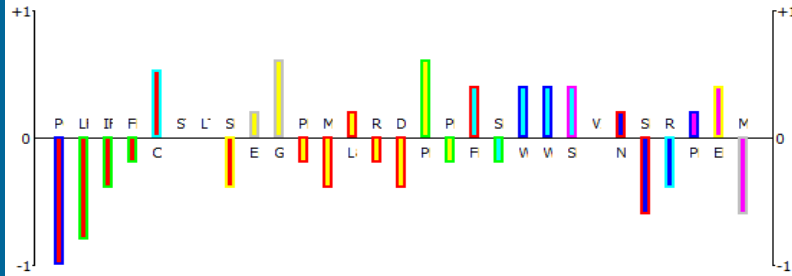


PROMETHEE findings:

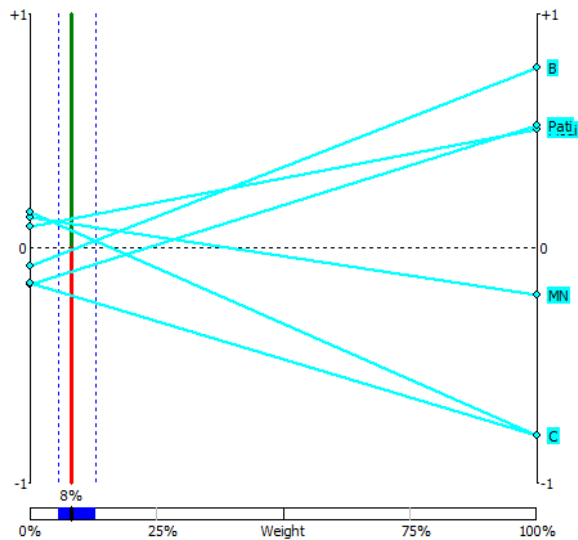
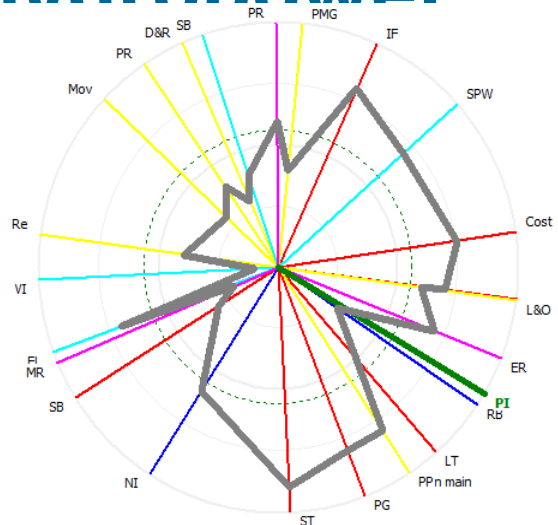
Finding null elements and analyzing sensitivity



Action profiles: Pati, Modi, MN, B, I, C



Decision Axis and GAIA web for Pati



Visual PROMETHEE Academic - Rana 6 sites experiment1.vppg (saved)

File Edit Model Control PROMETHEE-GAIA GDS GIS Custom Assistants Snapshots Options Help

	RPS	PG	LF	FC	IF	FD	Cost	ST	LT	SB	UL	Equ	Gen man	Lively	PR
Unit		kW	5-point	5-point	5-point	5-point	US\$/kW	5-point	5-point	5-point	5-point	5-point	5-point	5-point	5-p
Cluster/Group															
Preferences															
Min/Max		max	max	max	max	max	min	max	max	max	max	max	max	max	r
Weight		8,40	3,19	0,00											2
Preference Fn.		Linear	Usual	Usual											Us
Statistics															
Thresholds		absolute	absolute	absolute											absol
-Q: Indifference		25	n/a	n/a											n/a
-P: Preference		100	n/a	n/a											n/a
-S: Gaussian		n/a	n/a	n/a											n/a
Evaluations															
Path		996	average	bad											3,76
Mod		10000	good	bad											0,00
MN		14800	good	average											4,15
B		4200	good	average											3,19
I		7500	good	average											0,00
C		1500	average	bad											2

Weighing Assistant

Name	Mode: %	Lock	Hierarchical Weight
none	0,0%		0%
Economic	34,8%		35%
Power Generation	8,4%		8%
PG	8,4%		8%
Benefits impact	8,1%		8%
LF	3,2%		3%
FC	0,0%		0%
IF	3,2%		3%
FD	1,7%		2%
Cost of generation	8,1%		8%
Cost	8,1%		8%
Emp	10,1%		10%
ST	3,2%		3%
LT	3,2%		3%
SB	3,8%		4%
Local Resource use	0,0%		0%
UL	0,0%		0%
Social	25,0%		25%

Hierarchical Absolute Set Equal Apply Cancel

Decision framework developed:

S.N.	Criteria	Sub criteria	Elements , symbol and description	Weightage
1	Economic			0.35
		Power Capacity	PG=Yearly power generation	0.09
		Benefits		0.08
			LF= Local infrastructure developed due to project	0.03
			IF= Irrigation facilitated	0.03
			FD= Fishery developed	0.02
		Cost	Cost (C)= Total cost of project investment	0.08
		Employment		0.10
			ST= Directly related to project- short term 3	0.03
			LT= Directly related to project – long term 3	0.03
		SB= Indirectly related to project- secondary benefit	0.04	
2	Social			0.25
		Equity and Benefits		0.07
			Equ (EB)= Distribution, both cost (risk) and benefits	0.04
			Gen main (GM)= Gender main streaming, inclusiveness	0.03
		Project induced impacts		0.12
			PR= Power reliability and grid integration	0.03
			Mov (MA)= Movement: HH activities (farming, grazing)	0.02
			LO= Impact on law and order and local life style	0.03
			Re (RO)= Recreation opportunities	0.02
			DR= Displacement and resettlement of PAF	0.02
Transparency and Governance		0.06		
		PP = Public participation in Decision Making: 3	0.03	
		PMG (PM)= Partnerships in management/governance 3	0.03	
3	Environmental			0.10
		Degradation due to HPP	FL= Forest and biodiversity loss	0.02
		Sediment balance	SB= Tapping of sediment- riverbed scouring	0.02
		Impact on water resources	WQ= Water quality	0.02
			WC= Impact of water natural connectivity	0.02
		Solid waste and pollution	SPW (SW)= Solid waste, noise and vibration and also proper monitoring during construction	0.01
Visual impact	VI= On landscape due to project	0.01		
4	Political			0.15
		Contribution to national independence	NI= Project could support the independency	0.06
		Sector priority and PPP	SP= Power plant is as per the govt. preference.	0.04
		Regional balance	RB= Supporting regional balance of generation	0.05
5	Uncertainty			0.15
		Political (regulatory) risk	PR = Change in policy & priorities is political risk	0.06
		Environmental risk	ER= Climate change, greenhouse, land/rock movements	0.03
		Marketing and financing risk	MR= Change in market demand, competition & capital financing scenarios	0.06



THANK YOU