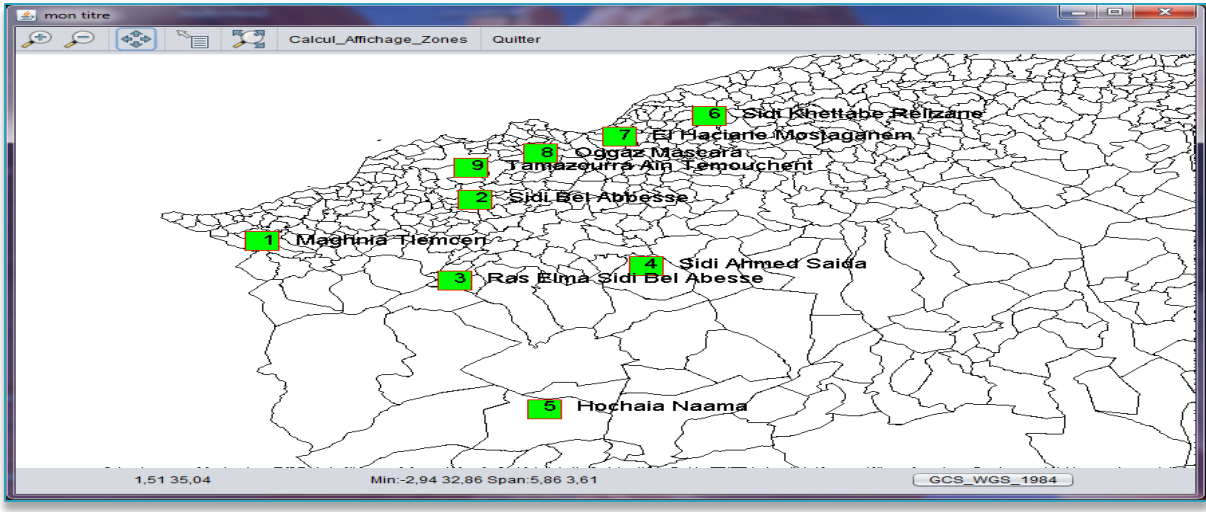
e-PROMETHEE Day 2020

PROMETHEE
METHODS



Exploring public sentiments for selecting industrial zones based on GIS-PROMETHEE integrated system

Presented by

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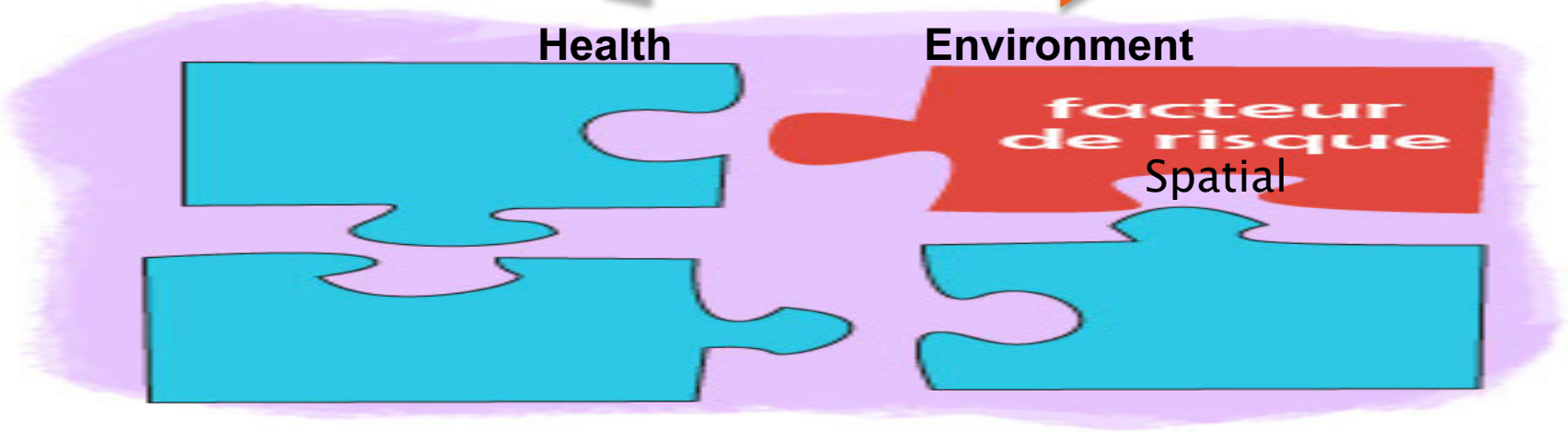
Outline

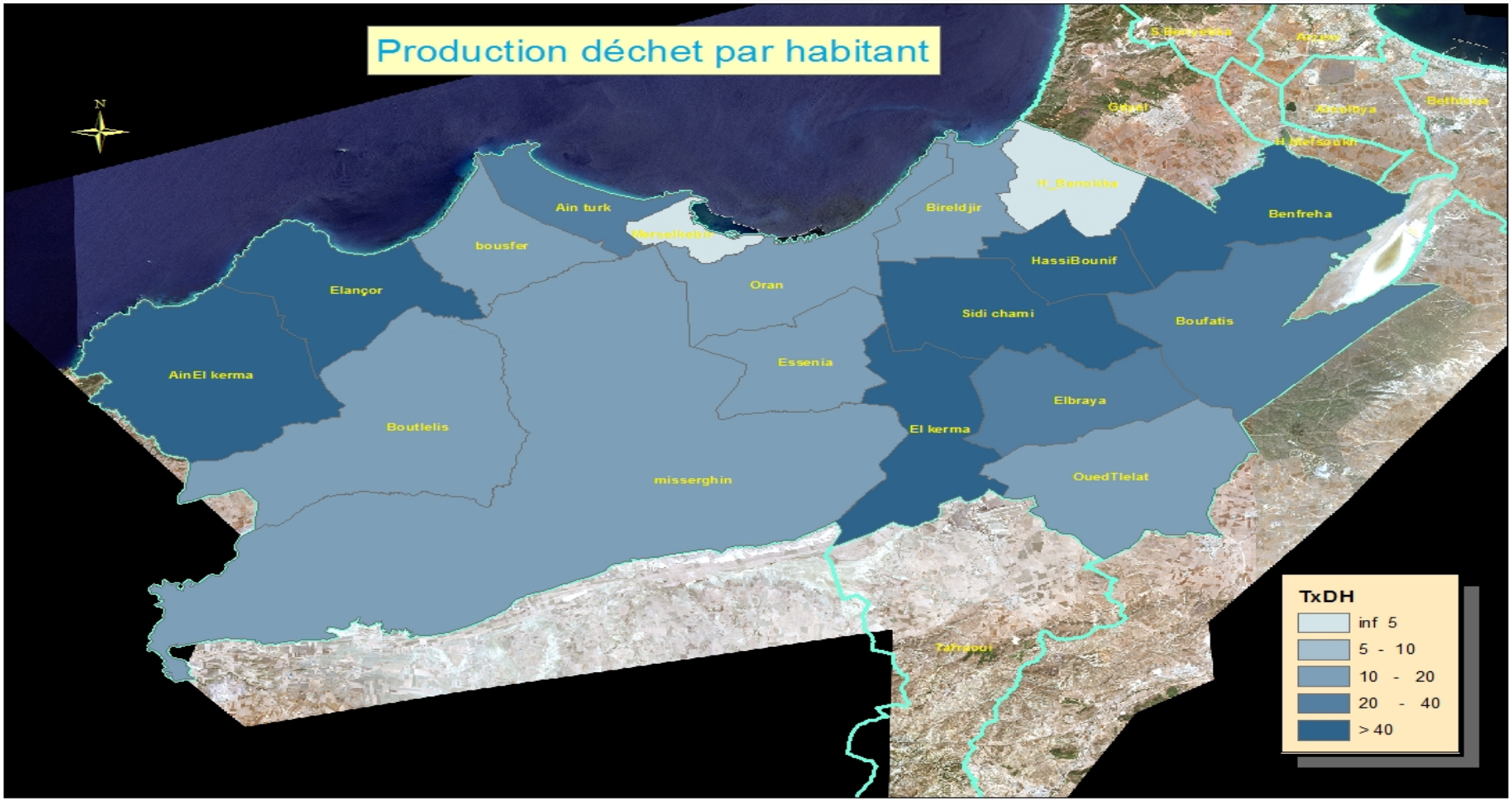
1. Introduction (Industrial zones)
2. Geographic information system (GIS)
3. Multi-criteria decision analysis (MCDA)
4. Integration GIS-MCDA
5. Contribution
6. Case study

Introduction

industrial zones



Introduction



Oran industrial zones (Arzew, Bethioua, Es-senia, Hassi ameur)

waste management optimization (ASA) ↓

Harmful waste

Introduction

Analysis

Mercury

Fat

harmful dust

CO

CO2

Lead

Nitrate

Deseases and epidemics

Introduction

. Economic and social necessity
. Instrument for the promotion of productive investment
. Vector of local development

. The Western Industrial Revolution
. The Asian economic launch

Introduction

LOCATION

Health risk

industrial zones

economic necessity

Geo-decisional problem

Caractérisée

Business intelligence

MCDA

Data mining

GIS

Simulation

IA

geographical aspect

Decisional aspect

- Large volume of data
- geographic and multidimensional data
- many stakeholders with conflicting preferences and divergent objectives
- multiple criteria often conflicting with varied weights

Dec ision support

led to

Decider

Environmentals and socio-economic criteria

An adequate location

Expand the gain

Decrease the risk

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GIS

Analyse

Monitoring

Mobility in the land

Management of contents

Mapping and visualization

Sharing and collaborating

SIG

Decision support

Acquire
analyze
store
mapping

Design and planning

Soufre

Geographical data

gaps

AMC

industrial localization support

Decision maker

GIS

GIS

Potentialités analytiques et Cartographiques

Exploit

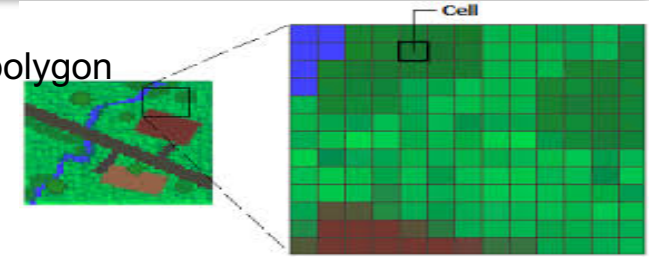
localization

> 80% of data

Geographical information

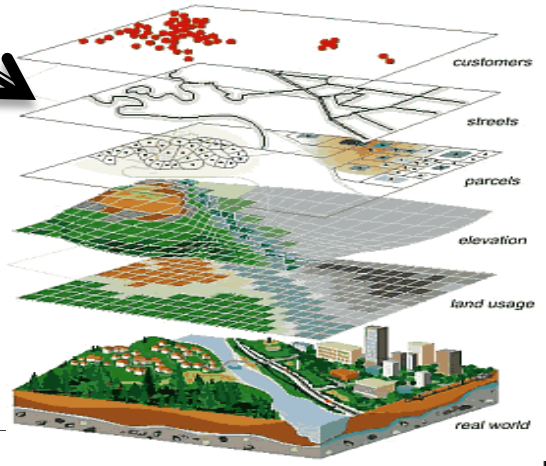
thematic layers

Point, line, polygon



vector

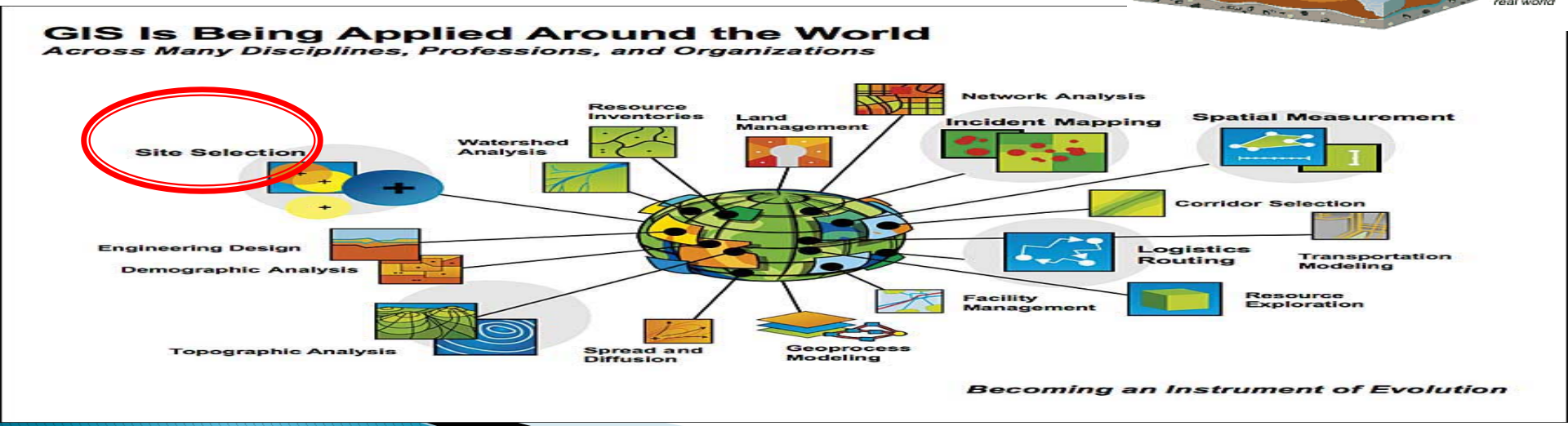
Raster



Development tools

Across the world

Selection of sites.
Land management.
Demographic analysis.
Corridors selection.



GIS and location science

The emergence of GIS led to the development of location theory

1- Murray, (2010)
2- Bin et Yao, (2006)
3- Church ,(2002)

Theoretical works

4- Chang, (2017)
5- Islam et al., (2016)
6- Shrivastava et al., (2015)

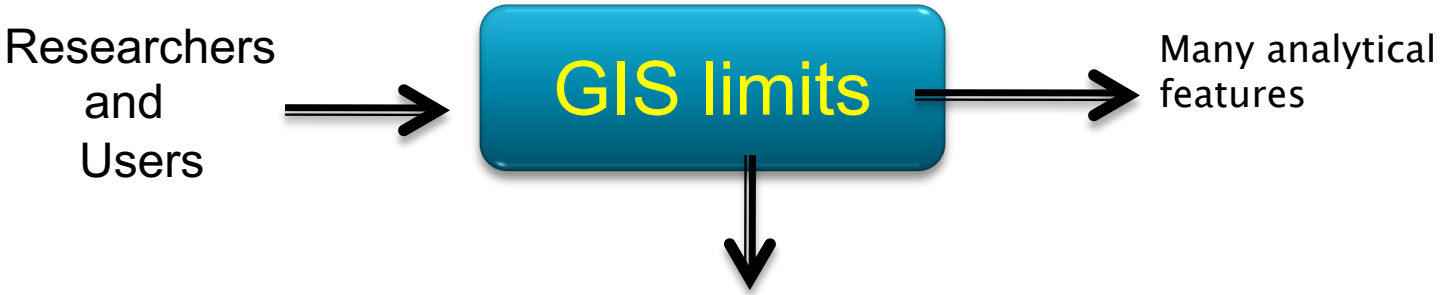
Applications

integrate mathematical location models into GIS

Location of landfills
Location of services…..

1- Advances in location modeling: GIS linkages and contributions, Journal of Geographical Systems .
2- Location-based services and GIS in perspective, Environment and Urban Systems .
3- Location modeling and GIS, book chapter.
4-Geographic Information System, The International Encyclopedia of Geography.
5- Municipal Solid Waste Management using GIS Application in Mirpur Area of Dhaka City, Bangladesh.
6- A Review of Solid Waste Management Techniques Using GIS and Other technologies", International Conference on Computational Intelligence and Communication Networks.

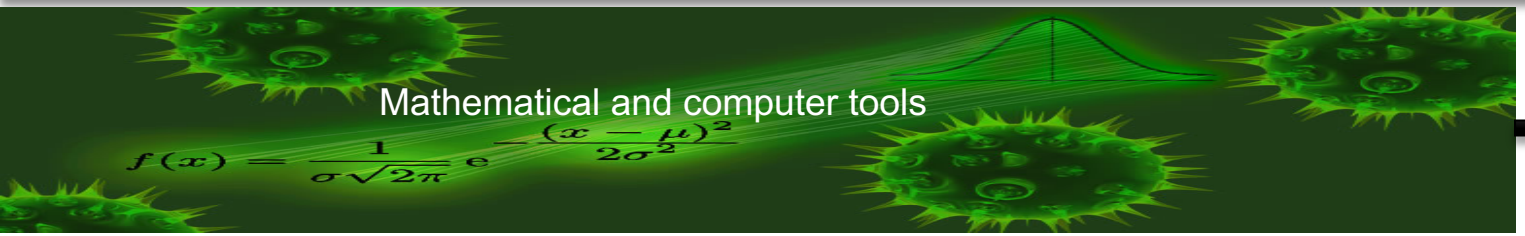
GIS limits



- Eligibility criteria, not assessment criteria
- Lack of multicriteria analytical functionality
- Limitations of overlay techniques
- Discretization of space
- A situation rich in data and poor in theory

- **(Atilio Francois, 2015)** SIG et aide à la décision: une nouvelle approche basée sur la logique floue.
- **(Chakhar, 2006)** Cartographie Décisionnelle Multicritère : Formalisation Et Implémentation Informatique,thèse de doctorat, LAMSADE et Université paris dauphine., France, 2006.
-**(Malczewski., 2004)** GIS-based land-use suitability analysis : A critical overview. *Progress in Planning,*
- **(Laaribi, 2000)** SIG et analyse multicritère , Hermès Sciences Publications, Paris, 2000.

GIS



GIS

MI tools	Authors
Programmation linéaire	**Cambell et al., (1992)**, **Chuvieco , (1993)**, ...
Statistique	**Burrough, (2001)** ; **Zhang et McGrath, (2004)**, ...
Multi-agents	**Sengupta et Bennett, (2003)**, **Brown et al., (1994)**, ...
Automate cellulaire	**Wu, (1998)** , **Batty et al., 1999)**, ...
Logique floue	**Stefanakis et al., (1999)** , **Yanar et Akyürek, (2006)**, ...
Intelligence artificielle	**Egenhofer et Frank, (1990)**, ...
Systèmes experts	**Khalid, (2006)** , **Fleming et al., (2007)**, ...
Réseaux de neurones	**Bennett et al., (1996)** , **Rigol et al., (2001)**, ...
Algorithmes génétiques	**Brooks, (2001)** , **Ducheyne et al., (2006)**, ...

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MCDA

Spatial décision problem

Alternatives (Actions spatiales)

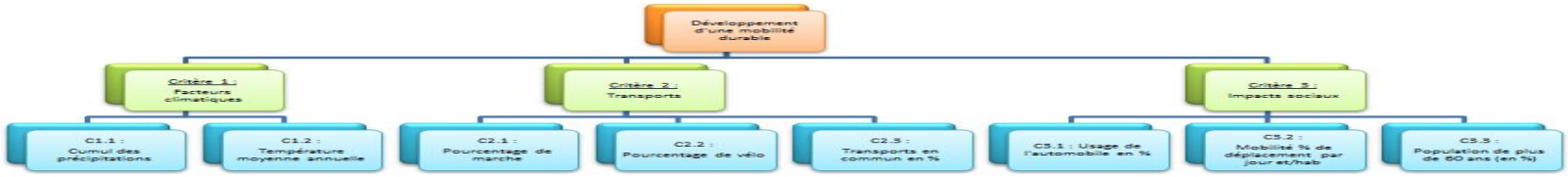
Criteria
- Multiple
- Confliting
- Incommensurate

decision-makers
managers, stakeholders
interest groups

Structuring

designing, evaluating and prioritizing alternative decisions

MCDA(techniques and procedures)



Formulation d'un problème monocritère

$$\text{Opt}\{(g(x)) \;/\; x \in A\}$$

Formulation d'un problème multicritère

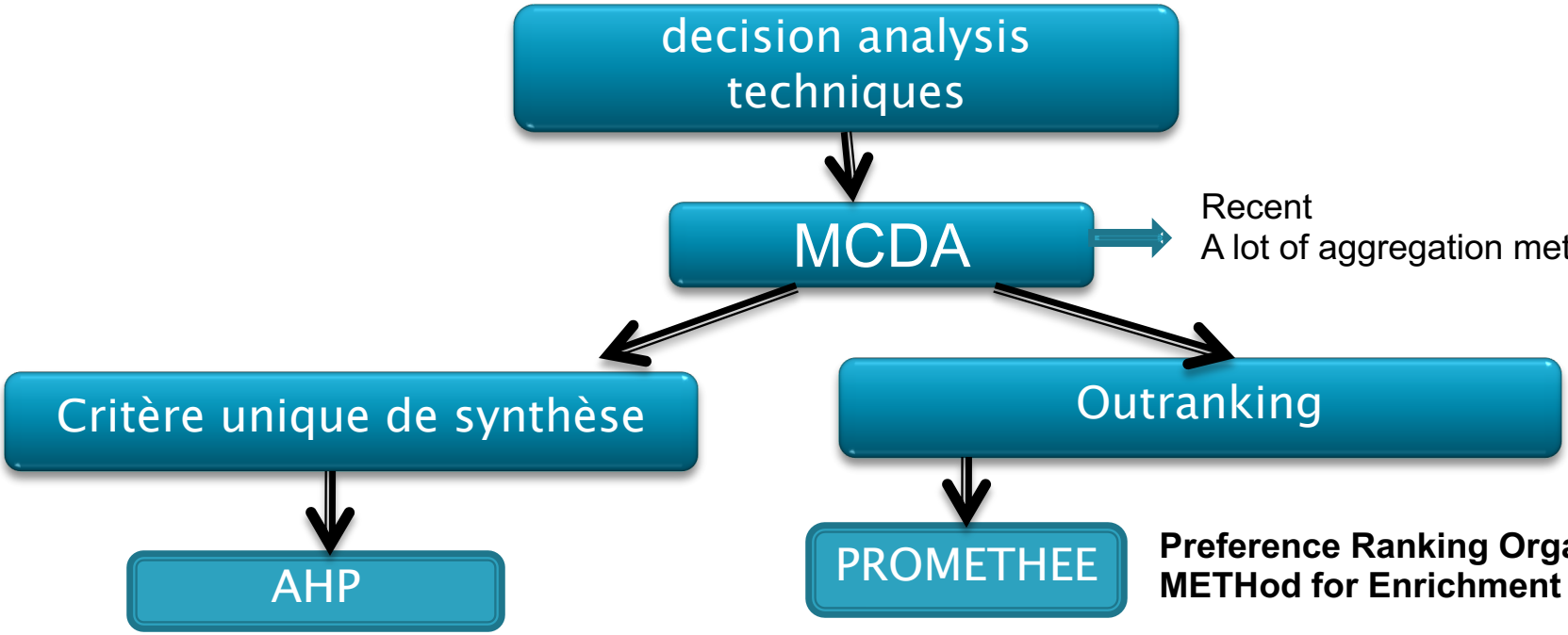
$$\text{Opt}\{(g_1(x), g_2(x) \ldots g_m(x)) \;/\; x \in A\}$$

gi désignent les fonctions critères .
A est l'ensemble des actions admissibles

Choose, sort, rank, describe

MCDA

MCDA



Analytic Hierarchy Process

(Saaty, 1980) Thomas L. Saaty "The Analytic Hierarchy Process", McGraw-Hill, 1980

The PROMETHEE I (partial ranking) and PROMETHEE II (complete ranking) were developed by J.P. Brans and presented for the first time in 1982 at a conference in LAVAL university (CANADA)

(Brans et Vincke, 1985) J. P. Brans and Ph. Vincke ,"A Preference Ranking Organisation Method: The PROMETHEE Method for Multiple Criteria Decision-Making", Management Science, Vol. 31, No. 6, PP. 647-656 ,1985.

MCDA

Domain	Application
Location	Khalil et al., (2003), Bernadette, (2007), Gourion et al., (2012), Martel et Aouni, (1992) ...
Land-use planning	Beinat et Nijkamp, (1998) ; Koo et Connell, (2006).
urban planning, environment	Lahdelma et al., (2000) ; Kiker et al., (2005).
Transport planning	Clímaco et al., (1993) ; Jankowski, (1995) ; Marius, (2009)
Water ressources	Raju et Pillai, (1999a) ; Raju et Pillai, (1999b) ; Petit et Bruno, (2009), Bachta, (1995).
Agriculture	Janssen et Rietveld, (1990) ; Francis , (2013)
Forest management	Tarp et Helles, (1995) ; Tecle, (1998)

Limits

- MCDA software does not dispose of spatial data management capacity .
- MCDA software lack of necessary mapping tool that can improve their understanding.

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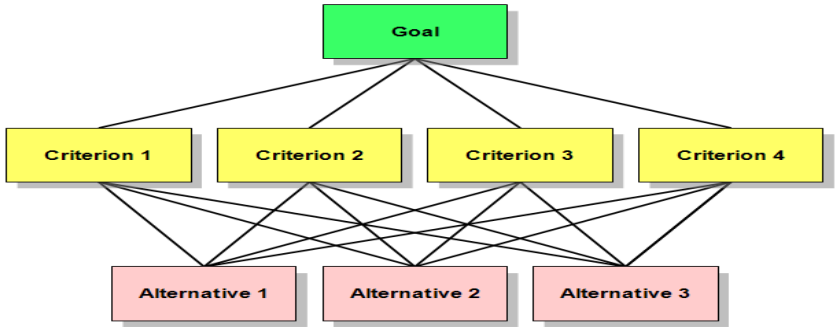
GiS-MCDA integration



<>

MCDA

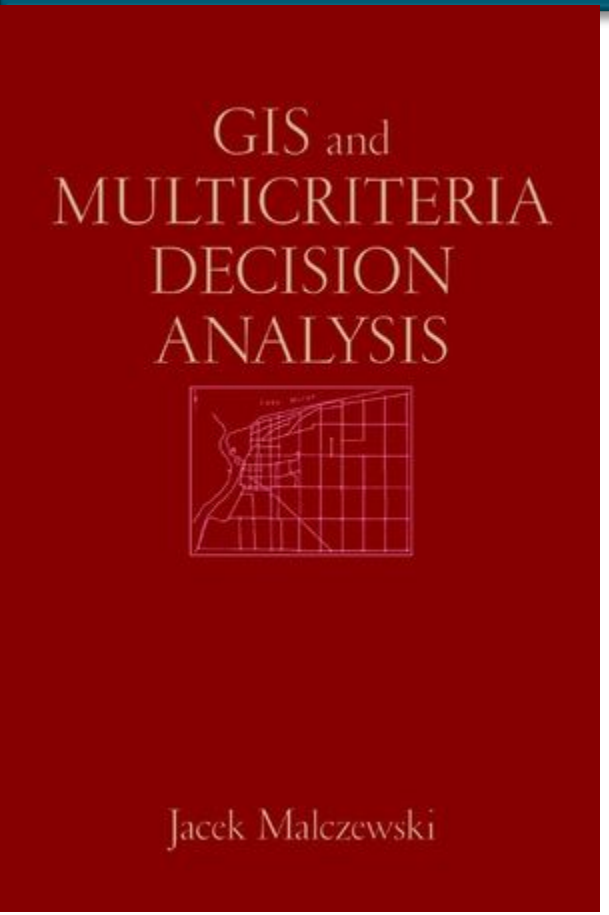
GIS

Decision support for industrial location

(GIS-MCDA) can be thought of as a process that transforms and combines geographical (spatial) data and value judgments (the decision maker's preferences) to obtain information for decision making" **Malczewski , (2010)**

L'intégration des SIG et de l'AMC constitue une voie privilégiée et incontournable pour faire évoluer les SIG vers de véritables systèmes d'aide à la décision . **LAARIBI, (2000)**

GIS-MCDA integration



GIS–MCDA Is needed

to transform and combine

Geographical data

And

Decision maker preferences

Information for decision support

GIS

Visualisation

Analytical capabilities

Visualise the result of MCDA

prepare the necessary inputs for the application of MCDA

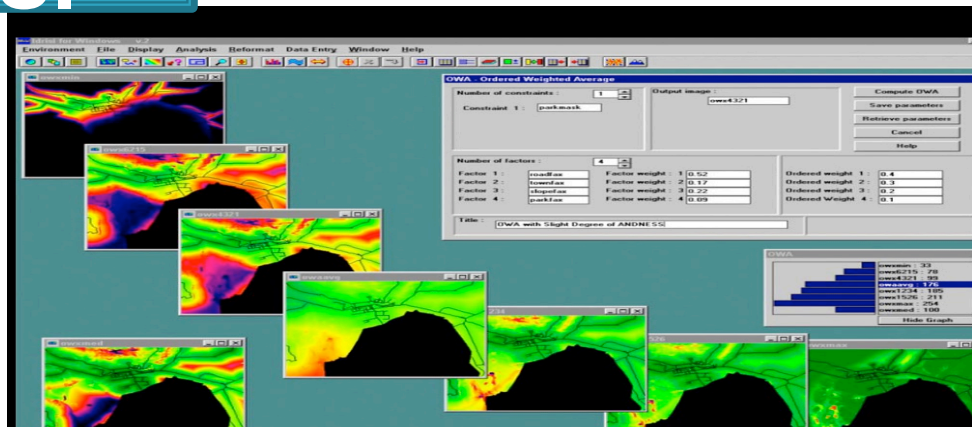
GIS-MCDA integration

technical aspect

MCDA → GIS

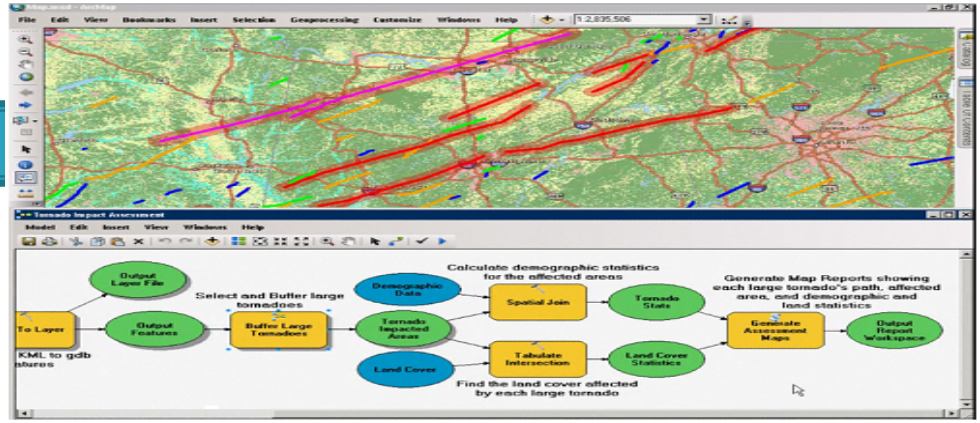
GIS-MCDA

IDRISSI



No coupling
Loose coupling
Tight coupling
Full integration

ARCGIS



Integration modes

Decision Evaluation in Complex Risk Network Systems → **DECERNS**

GIS-MCDA integration

GIS-MCDA

Theorical works

- Lidouh, (2013)
- Malczewski ,(2006)
- Chakhar, (2006)
- Marinoni ,(2006)
- Joerin et al., (2001)

First works

- Diamond et Wright, (1988),
- Janssen et Reitveld, (1990),
- Carver ,(1991),
- Langevin et al.,(1991)

On the motivation behind MCDA and GIS integration

GIS-based multicriteria decision analysis: a survey of the literature

- Une stratégie d'intégration SIG-AMC,
- Un module à base de règles pour le choix de la procédure d'agrégation à appliquer etc.

Compare les méthodes de surclassement et les méthodes de critère unique de synthèse pour l'intégration

Liaison entre SIG-AMC et aménagement du territoire

GIS-MCDA integration

Applications

GIS-MCDA

- Industrial zones selection — **Boutkhoum et al., (2015), Aleksandar et al., (2013), Marzieh et al., (2011), Khalid, (2003) , ...**
- Environnement — **Gianluca et al., (2014), Valentina et Silvia, (2011) Makram et al., (2008), Malczewski, (1996) , ...**
- Energy — **Maria et al., (2011), Dedemen, (2013), ...**
- Houssing — **Meng et al., (2011), Marinoni, (2005), Jorein et al., (2001), ...**
- Agriculture and hydrology — **Itami et al., (2000), Giupponi et al., (1999) Laaribi et al., (1996), ...**
- Transportation — **Jankowski et Richard, (1994), Younsi et al., (2009), ...**
- Others — **Martin et al., (2003), Sharifi et al., (2002), ...**

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Contribution and case study

MCDA

GIS

Decision making process

Intégration mixte

GIS

Modèle

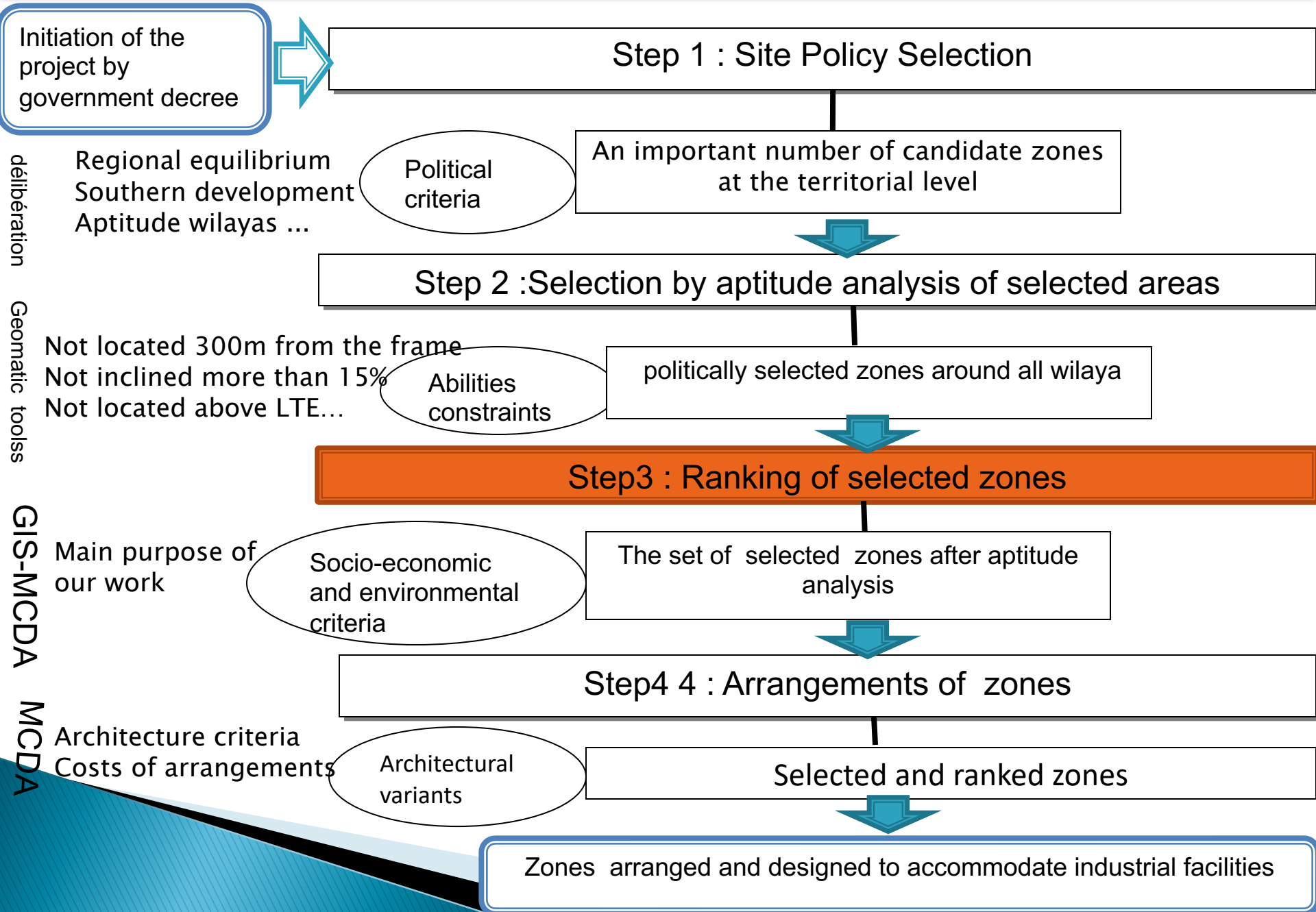
Promethee II

The Algerian public authorities have assigned to ANIREF an ambitious program of development of 49 new industrial parks totaling an area of 11,622 ha distributed through 39 Wilaya that cover 9 areas of territorial programming of the SNAT.

SNAT : Schéma National d'Aménagement du Territoire

ANIREF : Agence Nationale d'Intermediation et de Régulation Foncière

Contribution (Decision maker process)

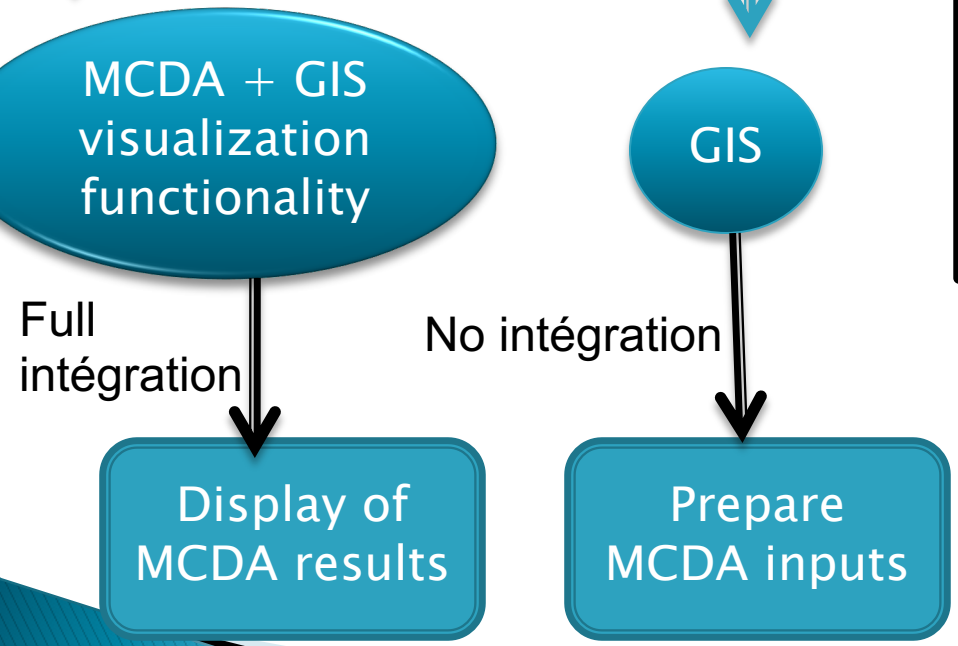


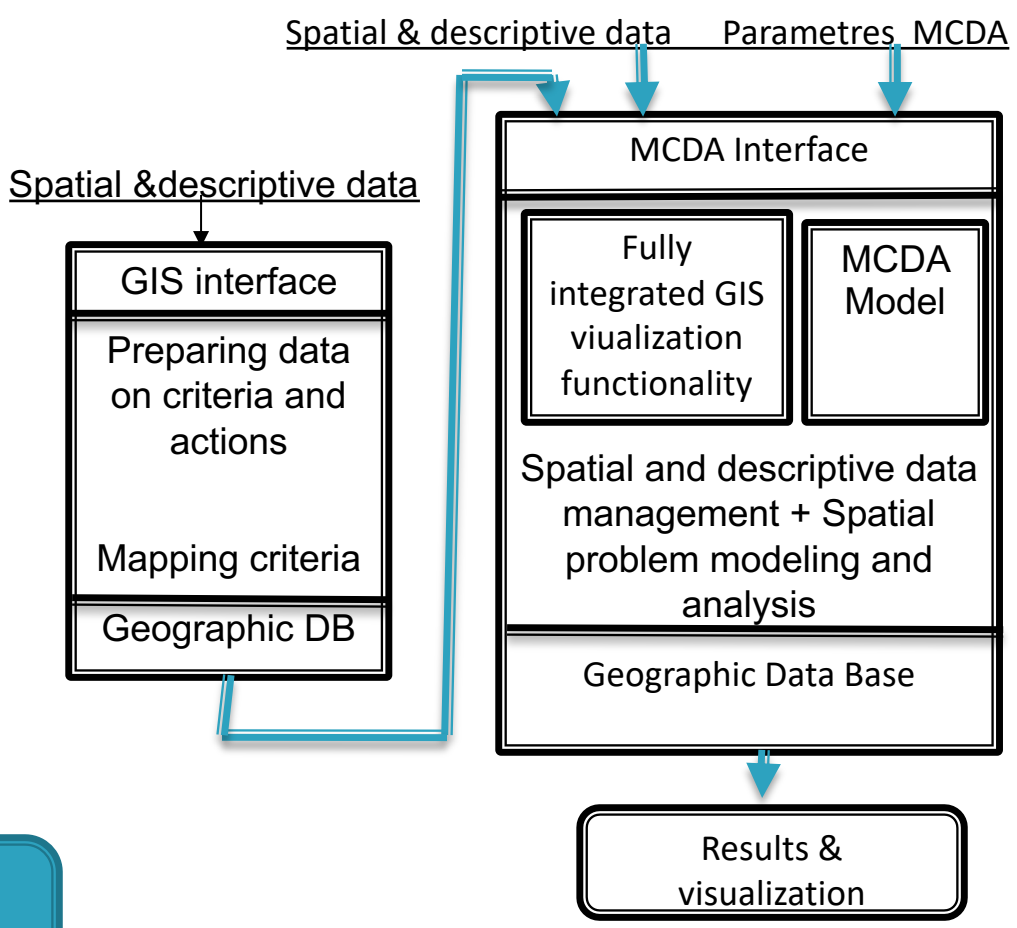
Contribution (Proposed integration mode for ranking)

(i) No coupling
(ii) Loose coupling
(iii) Tight coupling
(iv) Full integration

conceptual idea of integration

Mixed mode of integration





Contribution and case study (PROMETHEE II)

PROMETHEE (Preference Ranking Organisation METHods for Enrichement Evaluation) developed by Brans in 1982 and further extended by Brans and Vincke in 1985

- Simple understandable by the decision maker
- Allows partial ranking (PROMETHEE I)
- Allows total ranking (PROMETHEE II)
- Successfully used for site selection;
- Does not require a lot of information from the decision maker- ...

Outranking **a S b**

-**a** est au moins aussi bonne que **b** relativement à une majorité de critères sans être trop nettement plus mauvaise relativement aux autres critères

Generalized criterion=preference functions

Exprime

La préférence du décideur pour une action **a** par rapport à une autre action **b**.

(Brans et Vincke, 1985) J. P. Brans and Ph. Vincke , "A Preference Ranking Organisation Method: (The PROMETHEE Method for Multiple Criteria Decision-Making", Management Science, Vol. 31, No. 6, PP. 647-656 ,1985.

Contribution and case study (PROMETHEE II)

Required DATA (PROMETHEE INPUT

Performance table →

Critère/Action	C1	C2	C3	C4	C5	C6	C7	C8
A1	2	350	19	104	900592576	2500	3	14000
A2	2	310	24	100	867750000	4100	3	17000
A3	2	410	17	60	523765223	5000	3	13500
A4	2	380	19	100	867750000	6500	3	15000
A5	1	190	17	150	1301625000	3500	2	18000
A6	3	400	18	205	1778911797	3000	3	16500
A7	3	320	21	98	851772119	8100	3	18300
A8	4	350	20	200	1735585907	6500	3	13000
A9	3	370	19	500	4338750000	3000	2	17800
Sens de critère	Min	Min	Min	Max	Min	Min	Min	Max

1

the importance of each criterion in its group

Thresholds of indifference and preference ↓

Critère	C1	C2	C3
Préférence	2	22	560
Indifférence	1	11	280

3

Criteria weights ↓

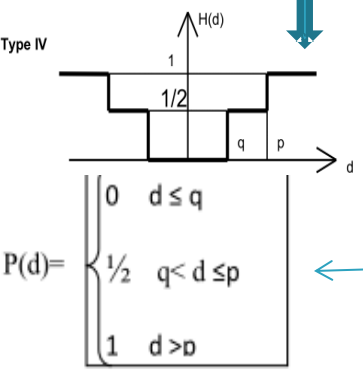
Critère	Poids
C1	30%
C2	40%
C3	30%

2

Contribution and case study (PROMETHEE II)

démarche d'utilisation de PROMETHEE II

Fonction: Usuelle, Quasi-critère, Linéaire, de critère à paliers, critère à préférence linéaire avec zone d'indifférence, critère gaussien



Ensemble des Critères

Ensemble des Actions

Table des Performances

Sens D'optimisation du critère

Comparaison par paire d'Actions

Seuil d'Indifférences

Seuil de Préférence

$$P_{j(a,b)} = G_j[f_j(a) - f_j(b)]$$

Fonction des préférences

Poids des Critères

Indice de préférence

$$\pi(a,b) = \sum_{j=1}^{k} P_j(a,b) w_j$$

Flux Sortant

$$\varphi^+(a) = 1/(m-1) \sum_{x \in A} \pi_r(x,a)$$

Flux Entrant

$$\varphi^-(a) = 1/(m-1) \sum_{x \in A} \pi_r(a,x)$$

Flux Global

$$\phi(a) = \phi^+(a) - \phi^-(a)$$

Rangement

Contribution and case study (PROMETHEE II)

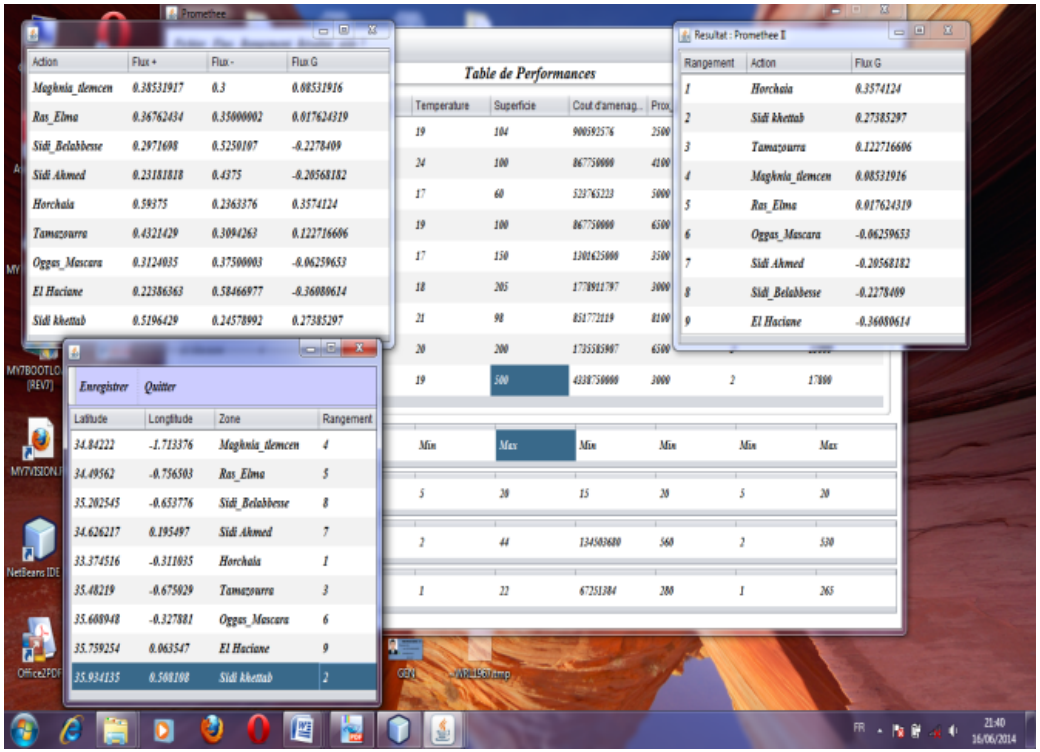
The **PROMETHEE Bibliographical database**
Contains 2218 references (16/01/2020) to scientific papers related to the **PROMETHEE** methods: theoretical developments, applications, comparisons with other methods, surveys,…
It is regularly updated and is available for download at: http://biblio.promethee-gaia.net

SIG

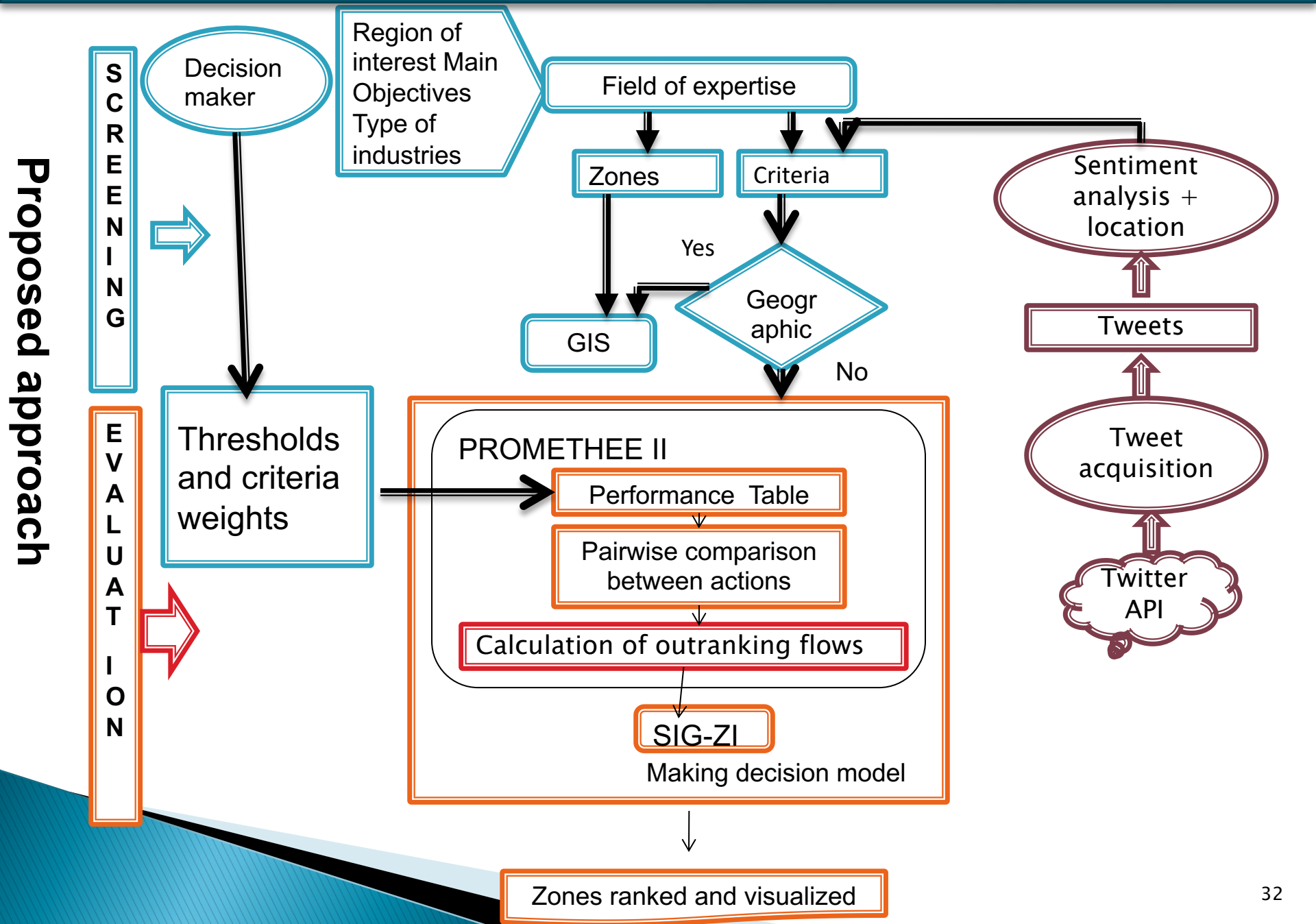
(Hassan et al., 2016)
(Hamadouche et al., 2014)
(Balali et Abbas, 2014)
(Dedemen, 2013)
Etc.

Bertrand Mareschal

PROMETHEE
METHODS



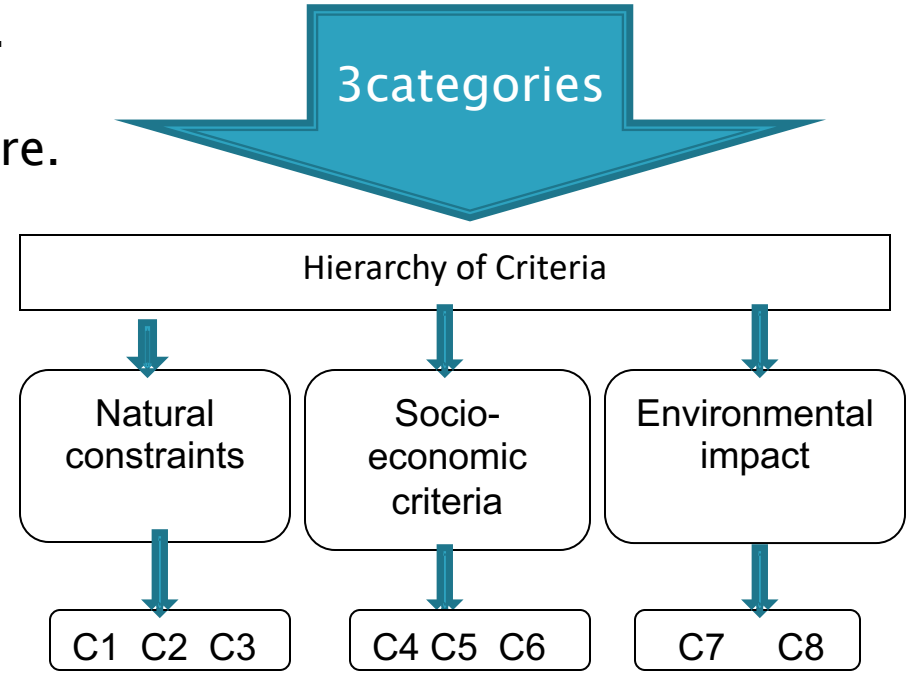
Contribution and case study (proposed approach)



Contribution and case study (PROMETHEE II)

List of criteria

C1: Seismicity.
C2: Rainfall.
C3: Temperature.
C4: Surface area.
C5: Management cost.
C6: Proximity to transport networks.
C7: Bioclimatics floor.
C8: Proximity to urban housing centre.

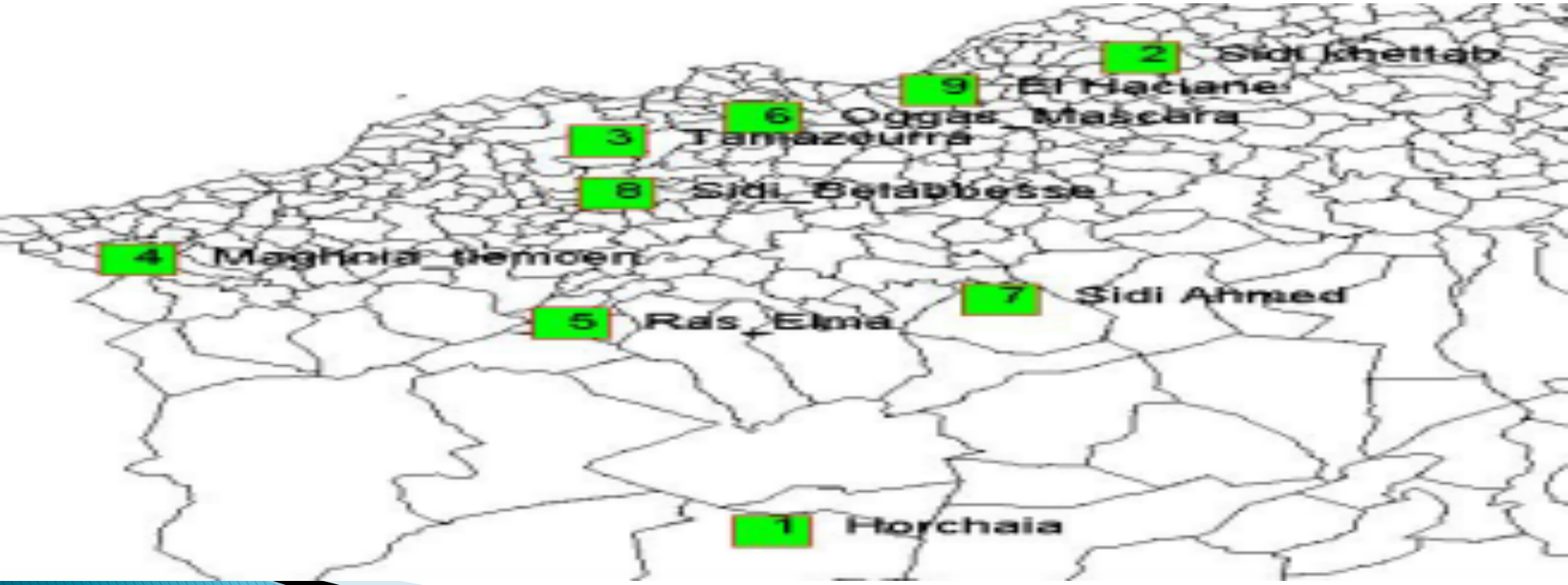


List of actions

A1 : Maghnia, Tlemcen.
A2 : Sidi Bel Abbes.
A**3:** Ras Elma, Sidi Bel Abbes.
A4: Sidi Ahmed, Saida.
A5 : Horchaia, Naama.
A6 : Tamazzoura, Ain Témouchent.
A7 : Oggas, Mascara.
A8 : El Haciane, Mostaganem.
A9 : Sidi khettab, Relizane)

Contribution and case study (PROMETHEE II ranking)

Les Zones	Flux positif (φ^+)	Flux négatif (φ^-)	Flux Global (φ)	Rang
A1 Maghnia	0.38531917	- 0.3	0.08531916	4
A2 SBA	0.2971698	0.5250107	- 0.2278409	8
A3 Ras El ma	0.36762434	0.35000002	0.017624319	5
A4 Saida	0.23181818	0.4375	- 0.20568182	7
A5 Naama	0.59375	0.2363376	0.3574124	1
A6 Tamazougha	0.4321429	0.3094263	0.122716606	3
A7 Oggas	0.3124035	0.37500003	- 0.06259653	6
A8 Elhaciane	0.22386363	0.58466977	- 0.36080614	9
A9 Sidi khatab	0.5196429	0.24578992	0.27385297	2



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Conclusion

MCDA

GIS

- ✓ The GIS-MCDA integration approach is used for the selection of industrial zones.
- ✓ A mixed integration mode is proposed.
- ✓ A ranking based on PROMETHEE II method is accomplished.
- ✓ We are in the process of gathering the opinions of citizens to integrate this criterion to overcome all possible quarrels and to democratize the selection of sites.