



Example of Risk prevention plan in Provence Alpes Côte d'Azur Region by BRGM Regional Department

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BRGM Regional Department Provence Alpes Côte d'Azur

Monday June 24th 2013

Le BRGM in short

- > **BRGM** is the reference establishment in the field of the Earth sciences www.brgm.fr
- **Status** : Industrial & commercial public establishment EPIC – State supervision:
 - Ministry of Research
 - Ministry of Ecology
- **4 missions** :
 - Scientific research
 - Connections to public politics
 - International cooperation & development aid
 - Prevention and mining security



Different scales of studies



Different scales of studies

Research Program about instabilities of coastal cliffs in PACA Region and in Carry-le-Rouet coastline – VALSE Program



Local analyse – city



Department
1/10 000^e



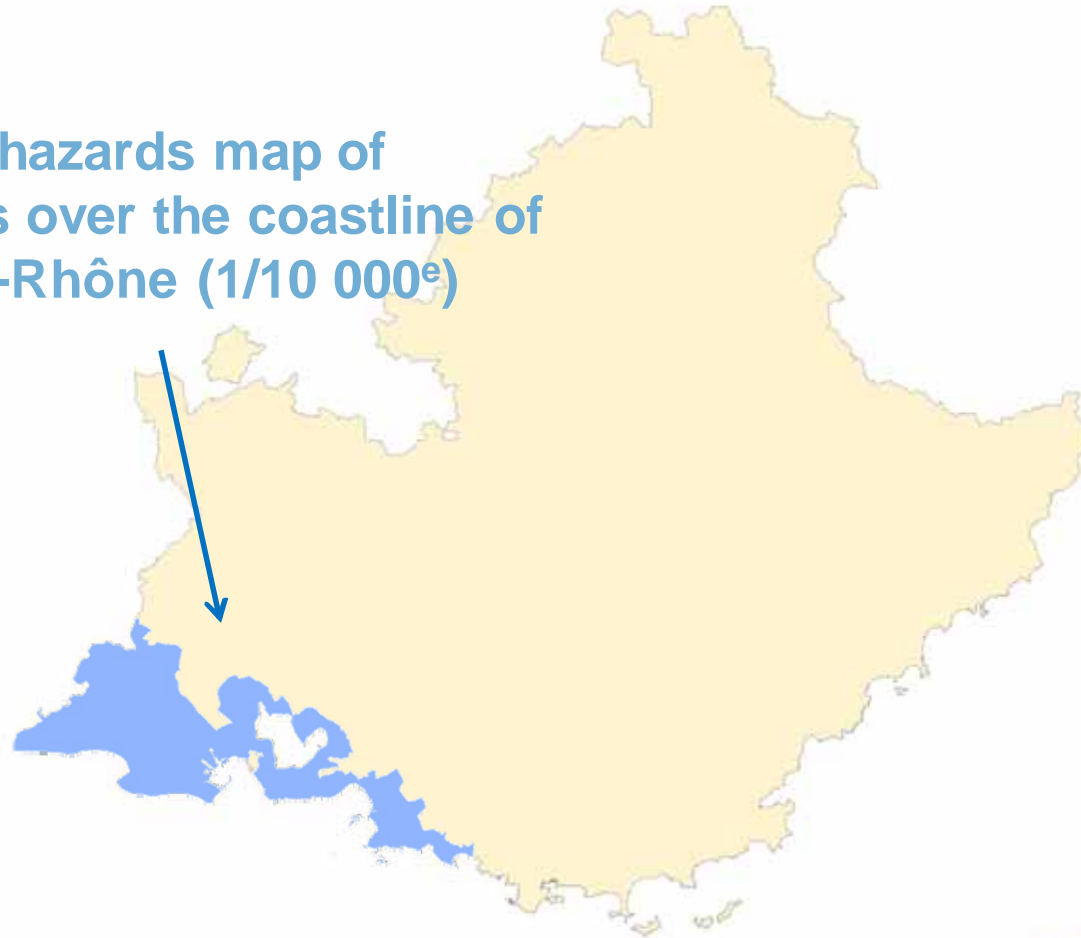
Risk area
1/25 000^e &
1/50 000^e



Regional area
1/100 000^e

Different scales of studies

Instabilities hazards map of coastal cliffs over the coastline of Bouches-du-Rhône (1/10 000^e)



Local analyse –
city



Department
1/10 000^e



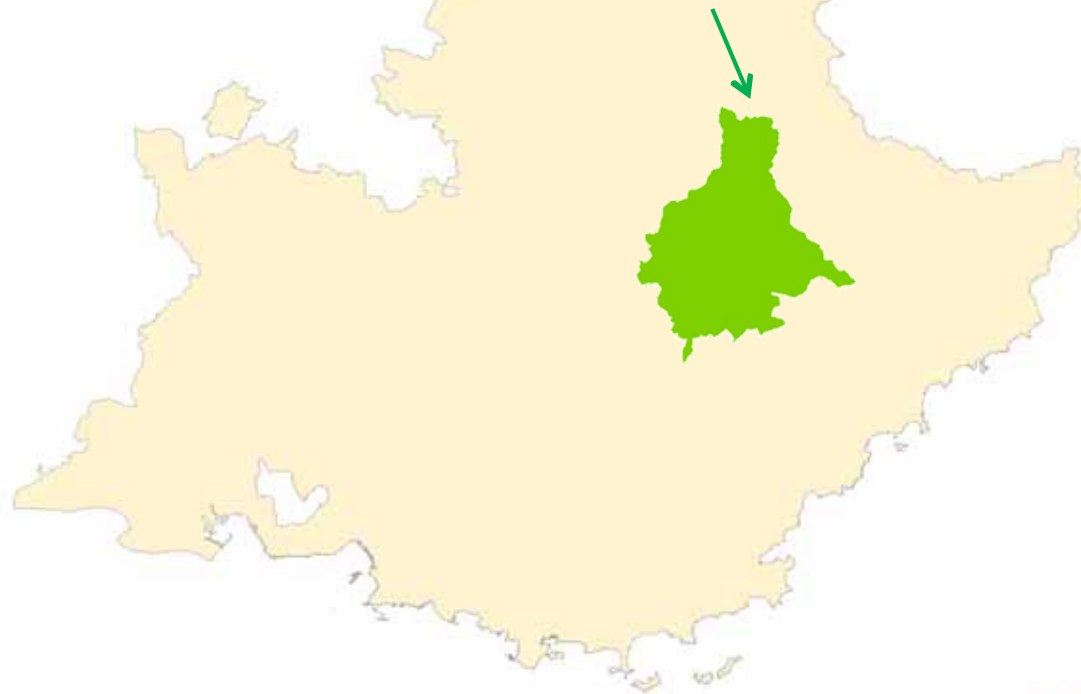
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Multirisk approach for the «Pays A3V» at 1/50 000^e and 1/25 000^e (Alpes de Haute-Provence)



Local analyse – city



Department
1/10 000^e



Risk area
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Regional area
1/100 000^e



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Different scales of studies

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Local analyse – city



Department
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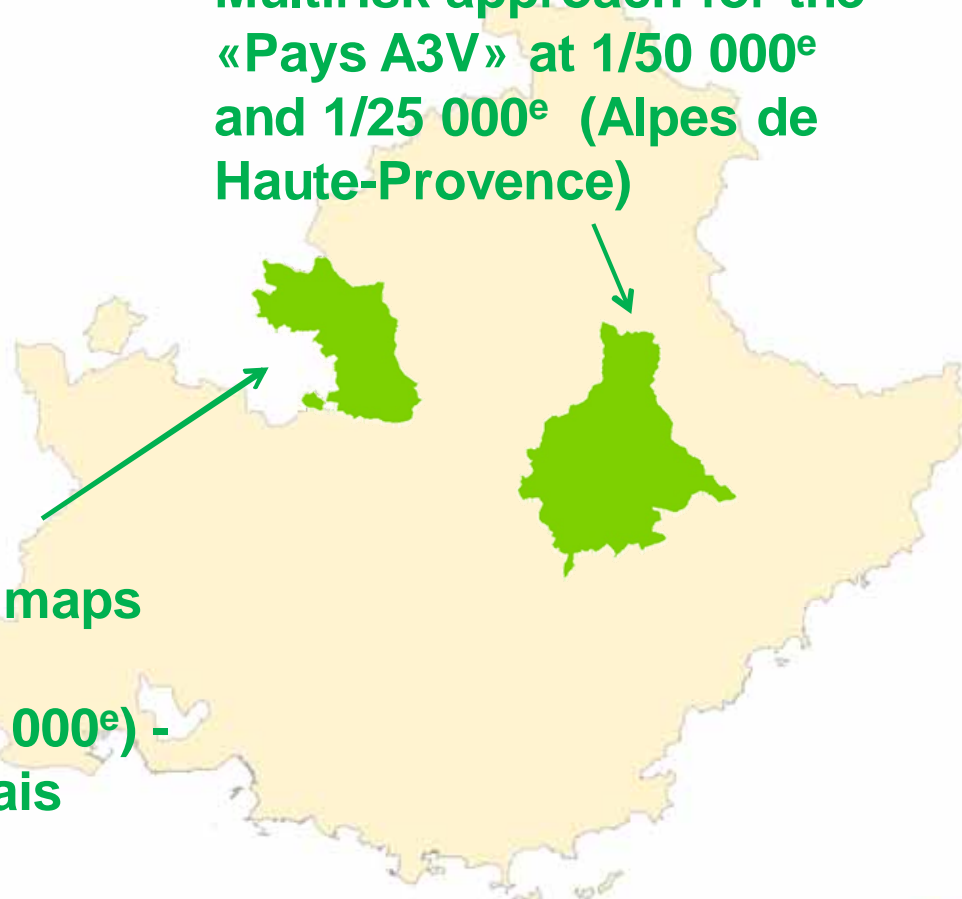


Risk area
1/25 000^e &
1/50 000^e



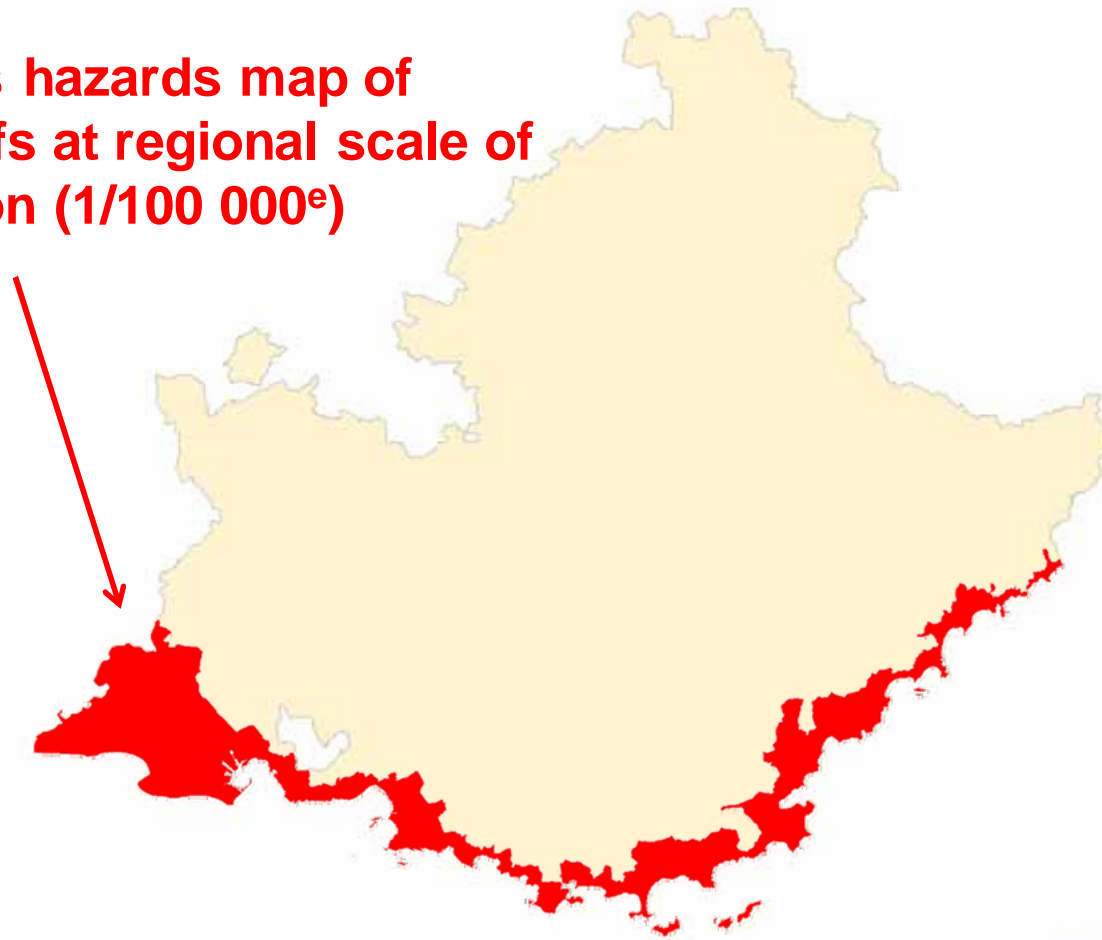
Regional area
1/100 000^e

Instabilités hazard maps
at risk area scale
(1/50 000^e and 1/25 000^e) -
Bas Buëch Laragnais
(Hautes-Alpes)



Different scales of studies

Instabilities hazards map of coastal cliffs at regional scale of PACA region (1/100 000^e)



Local analyse –
city



Department
1/10 000^e



Risk area
1/25 000^e &
1/50 000^e



Regional area
1/100 000^e



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Different scales of studies

Instabilities hazard map at regional scale on PACA Region (1/100 000^e)



Local analyse – city



Department
1/10 000^e



Risk area
1/25 000^e &
1/50 000^e



Regional area
1/100 000^e



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Different scales of studies & objectives

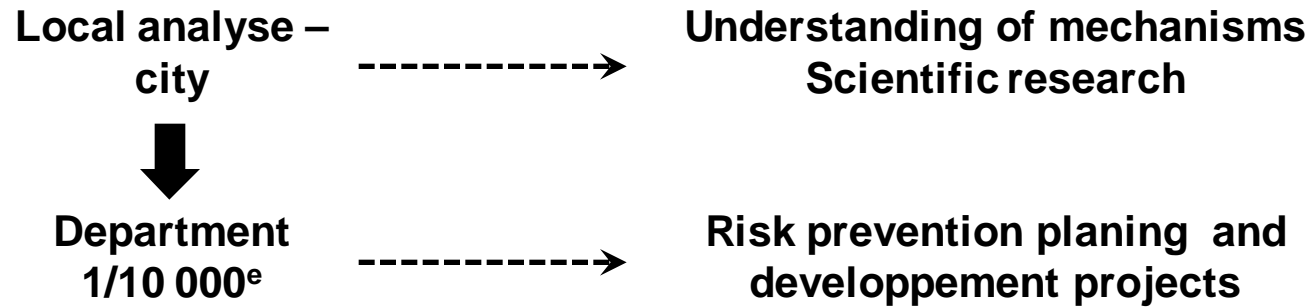
Local analyse –
city



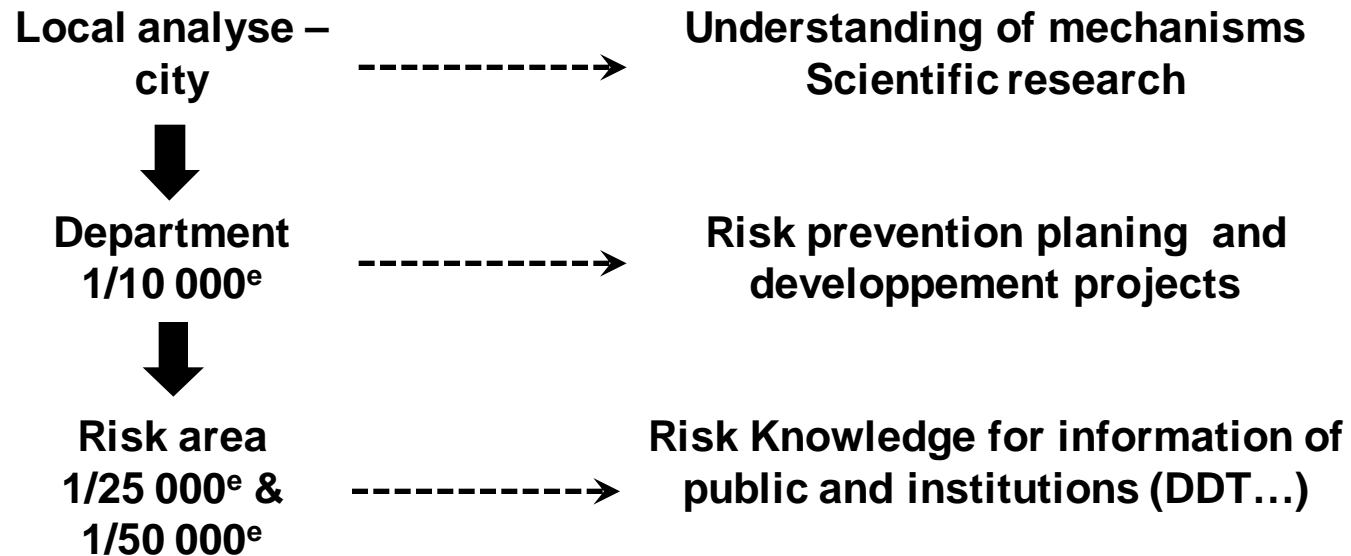
Understanding of mechanisms
Scientific research



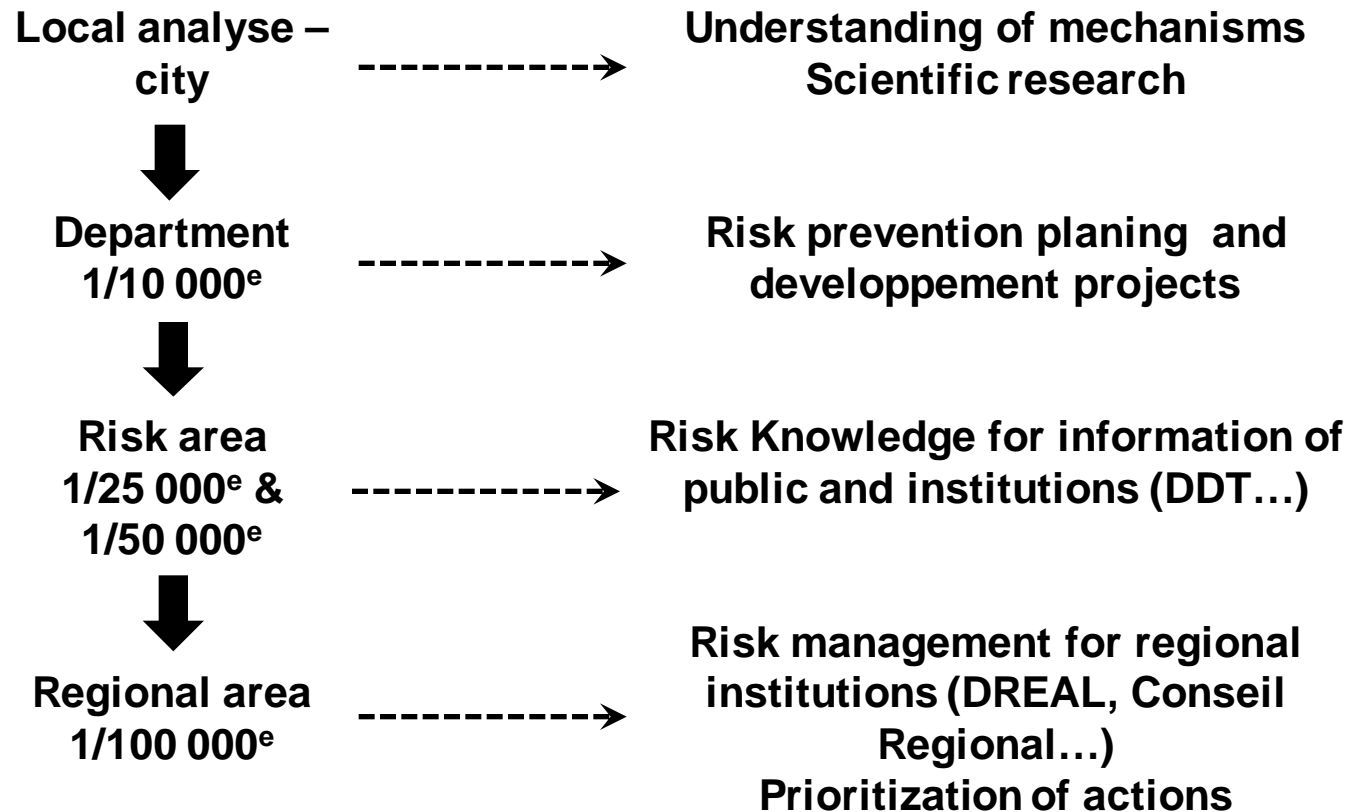
Different scales of studies & objectives



Different scales of studies & objectives



Different scales of studies & objectives



Plan

- 1- Research Program about instabilities of coastal cliffs in PACA Region ;**
- 2- Instabilities hazards map of coastal cliffs at regional scale over the coastline of Bouches-du-Rhône department (1/10 000^e) ;**
- 3- The multirisk approach for the «Pays A3V» (Alpes de Haute-Provence) at 1/50 000^e and 1/25 000^e ;**
- 4- Instabilites hazard maps at risk bassin scale (1/50 000^e and 1/25 000^e) - Bas Buëch Laragnais (Hautes-Alpes) ;**
- 5- Instabilities hazards map of coastal cliffs at regional scale of PACA Region (1/100 000^e) ;**
- 6- Instabilities hazard map at regional scale on PACA Region (1/100 000^e).**



Plan

1- Research Program about instabilities of coastal cliffs in PACA Region ;

2- Instabilities hazards map of coastal cliffs at regional scale over the coastline of Bouches-du-Rhône department (1/10 000^e) ;

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5- Instabilities hazards map of coastal cliffs at regional scale of PACA Region (1/100 000^e) ;

6- Instabilities hazard map at regional scale on PACA Region (1/100 000^e).





1- Research Program about instabilities coastline risk in Provence Alpes Côte d'Azur region – VALSE project

(Vulnérabilité et Adaptation pour Les Sociétés face aux Erosions de falaises côtières en région PACA)



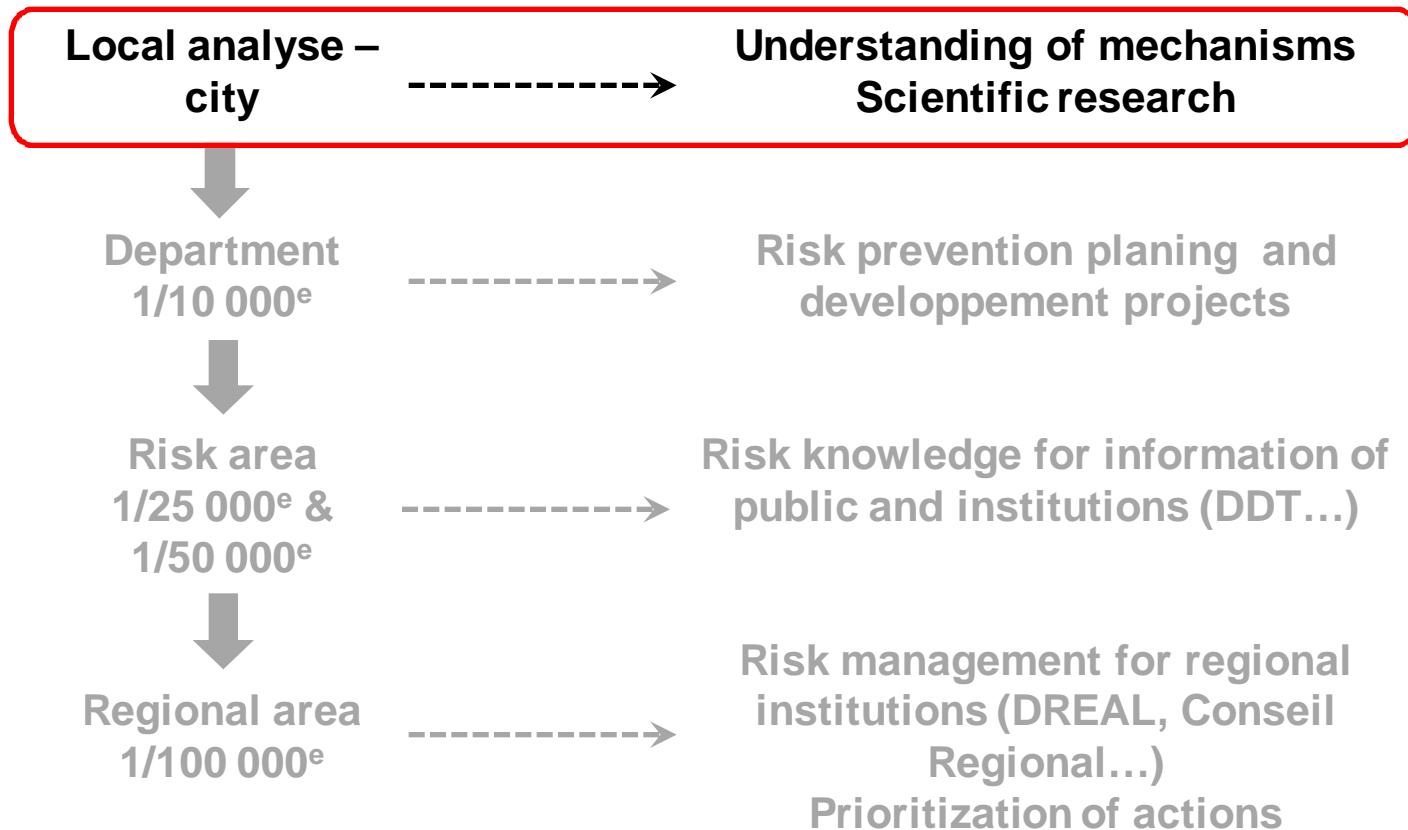
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BRGM Regional Department Provence Alpes Côte d'Azur

Monday June 24th 2013

Different scales of studies & objectives



Title : « Multi-temporal and multi-scale mechanism of coastline cliff evolution in PACA region, and more particularly in Côte Bleue (13) »

PhD student : Jérémy GIULIANO

Supervision :

Thomas LEBOURG (GeoAzur)

Vincent GODARD (CEREGE)

Nathalie MARÇOT / Thomas DEWEZ (BRGM)

PhD objectives



Title : « Multi-temporal and multi-scale mechanism of coastline cliff evolution in PACA region, and more particularly in Côte Bleue (13) »

Objectifs :

- 1. Identify the mechanisms of platform / cliff system (intern & extern parameters) ;**



PhD objectives



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- 2. Determine the morphodynamical response of the platform / cliff system ;**



PhD objectives



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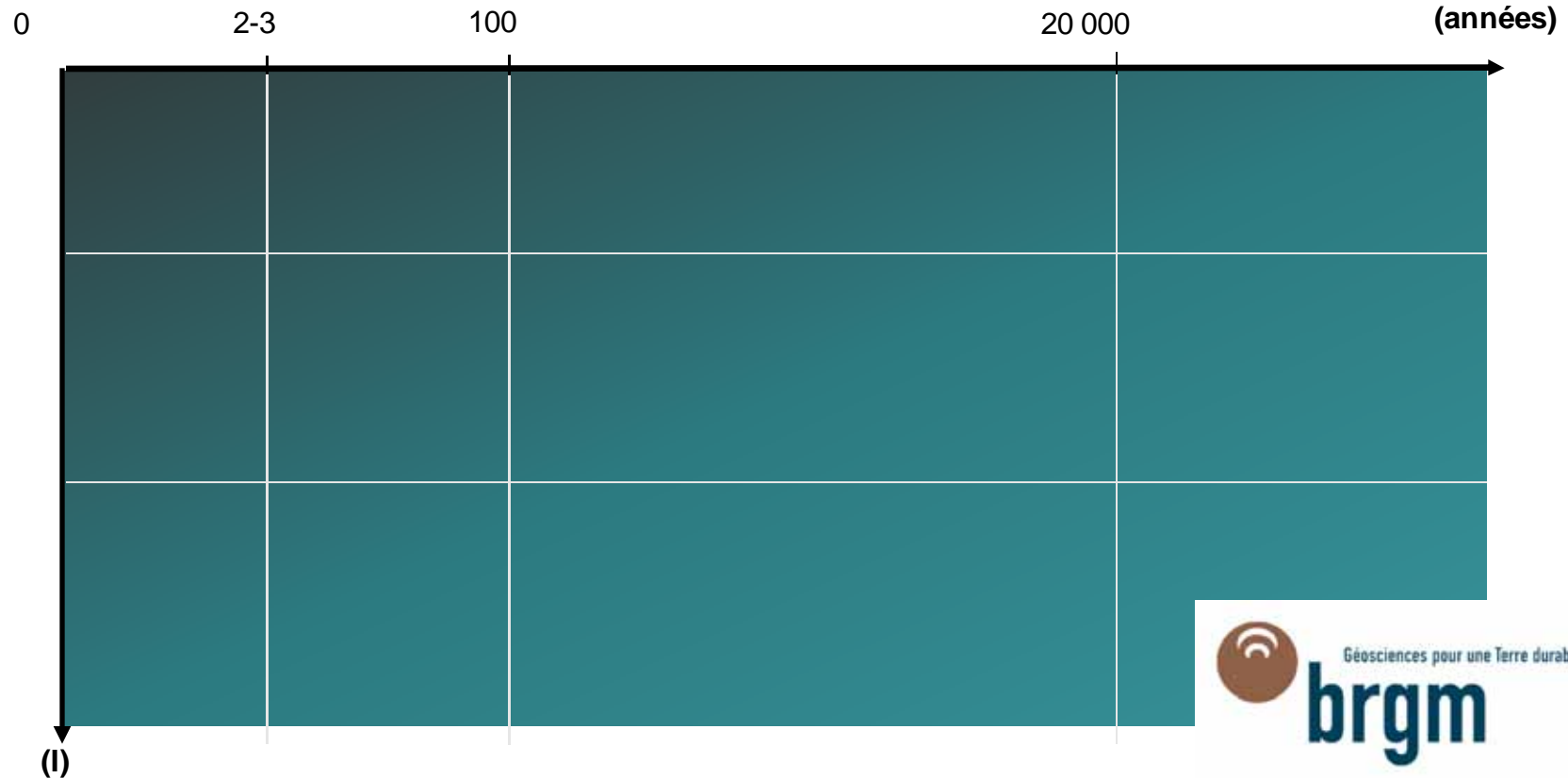
- 1. Identify the mechanisms of platform / cliff system (intern & extern parameters) ;**
- 2. Determine the morphodynamical response of the platform / cliff system ;**
- 3. Quantify spatio-temporal evolution of the platform / cliff system.**



Working axes



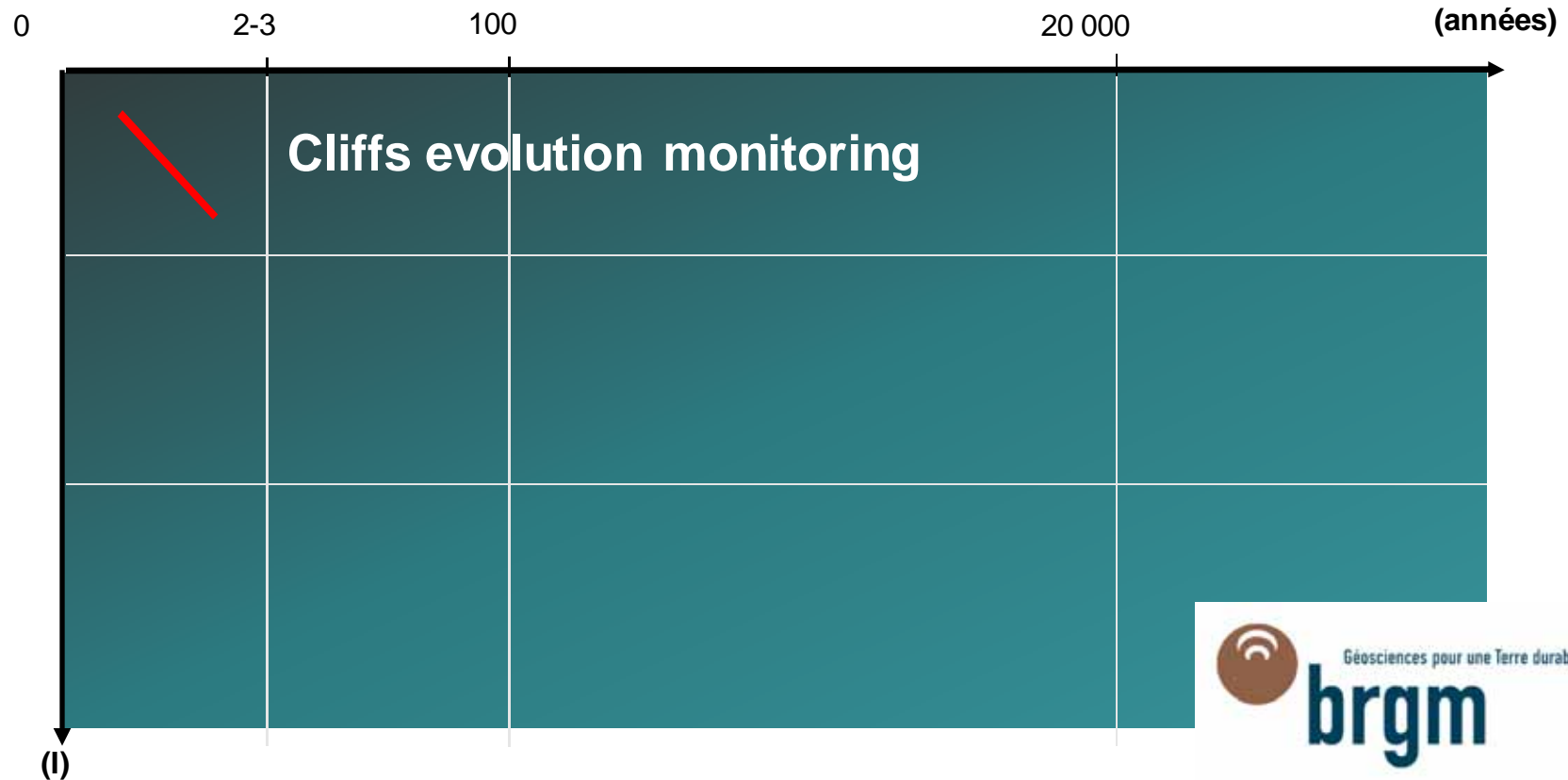
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Working axes



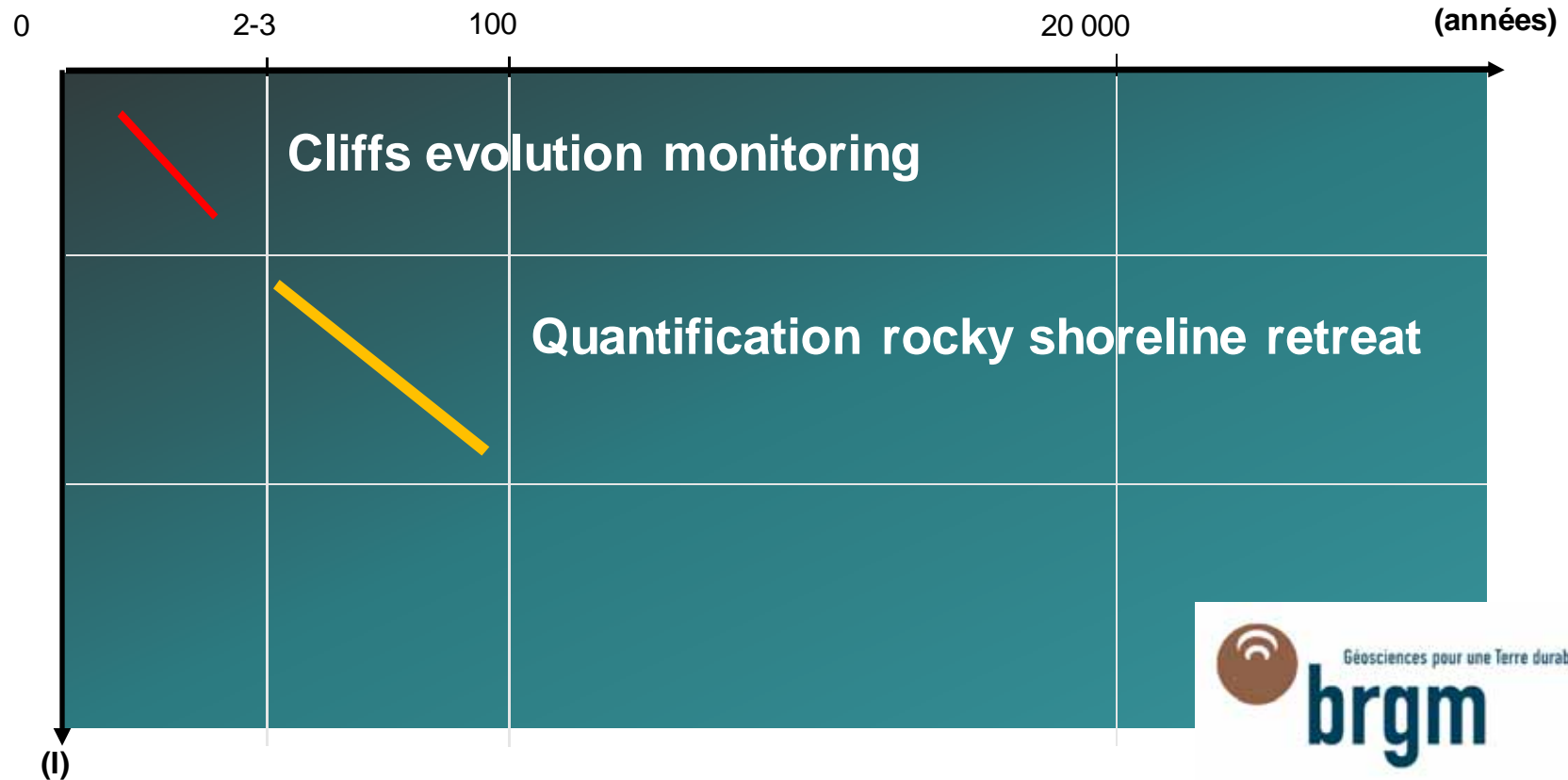
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Working axes



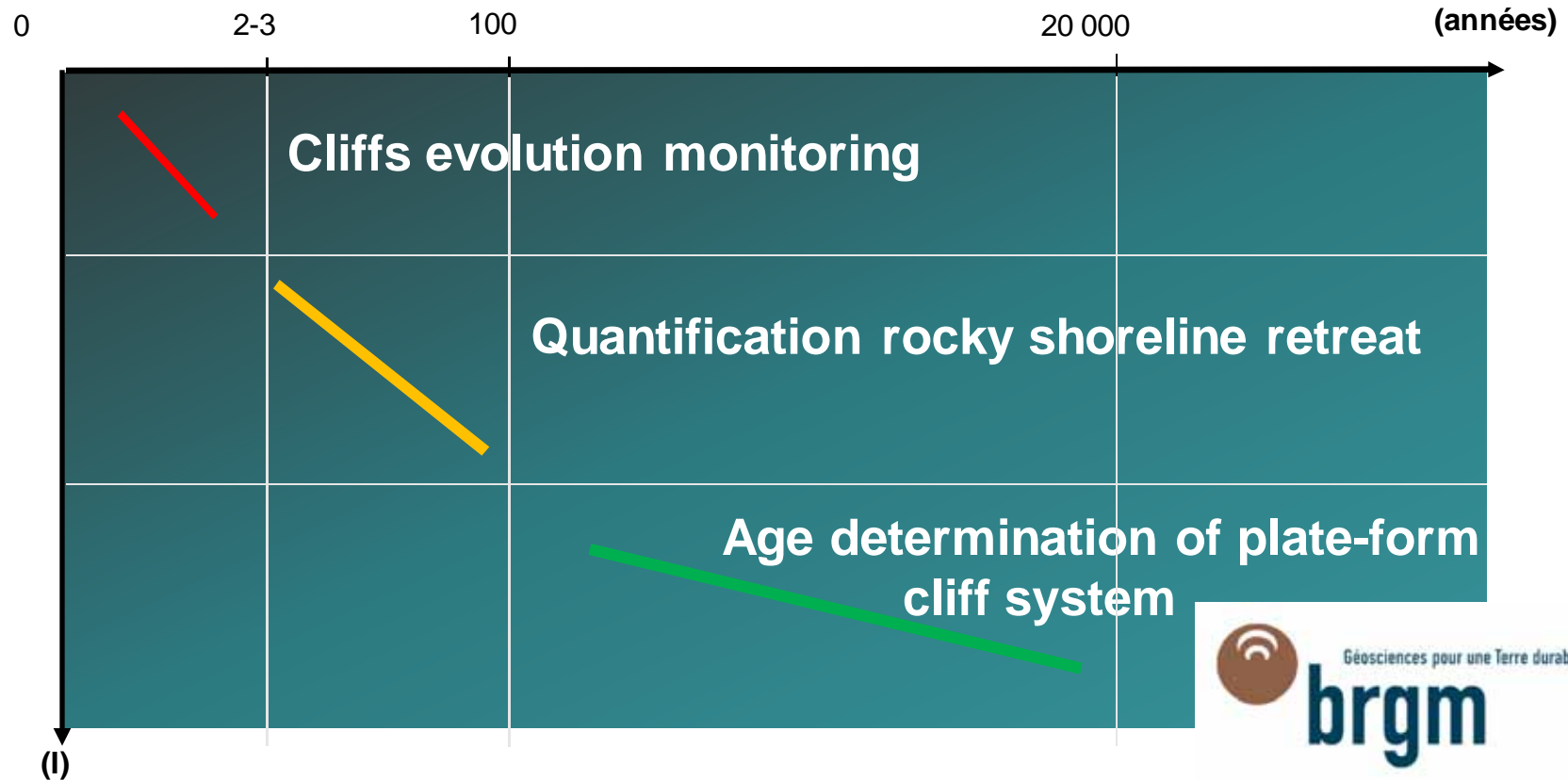
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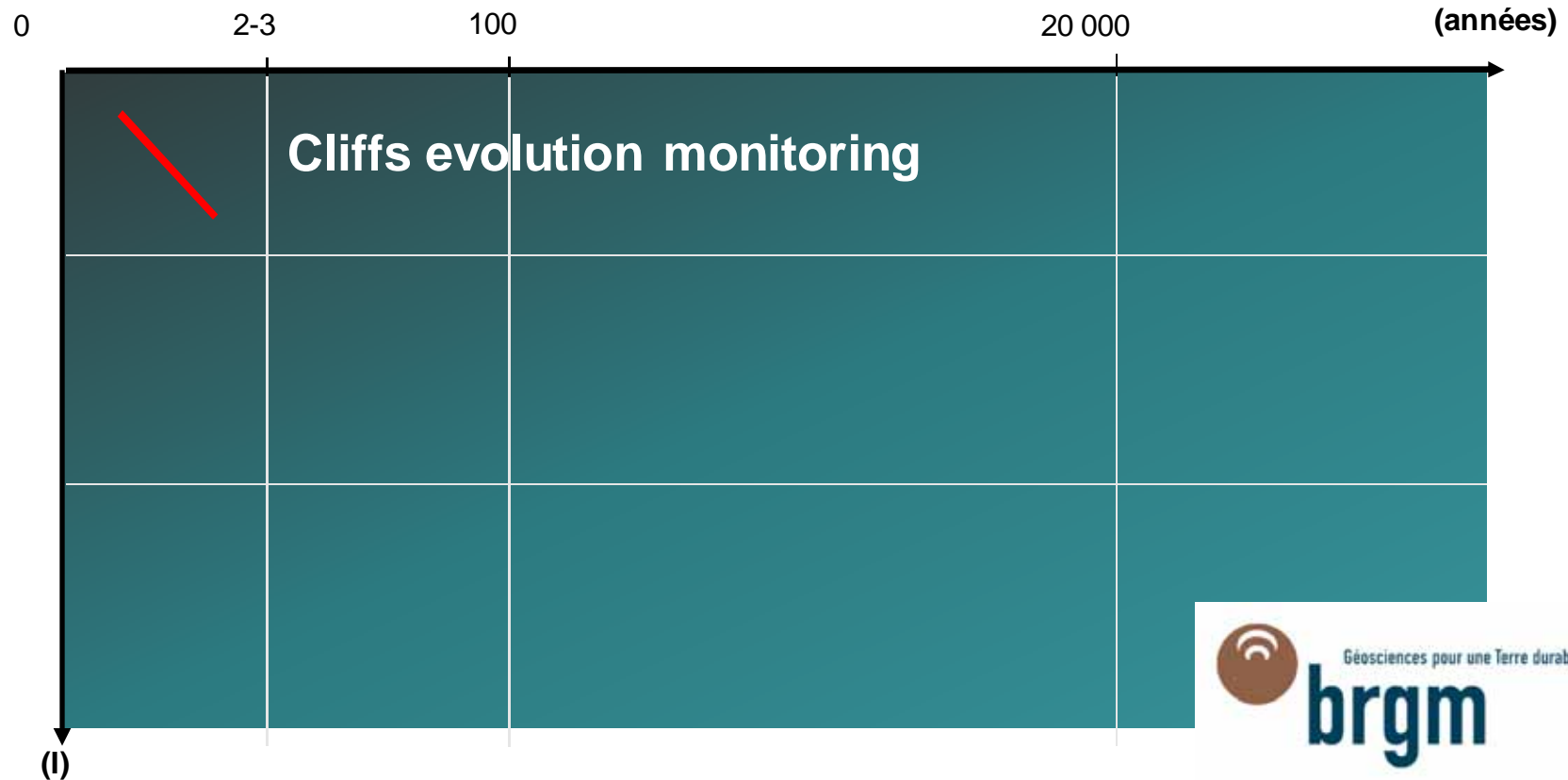
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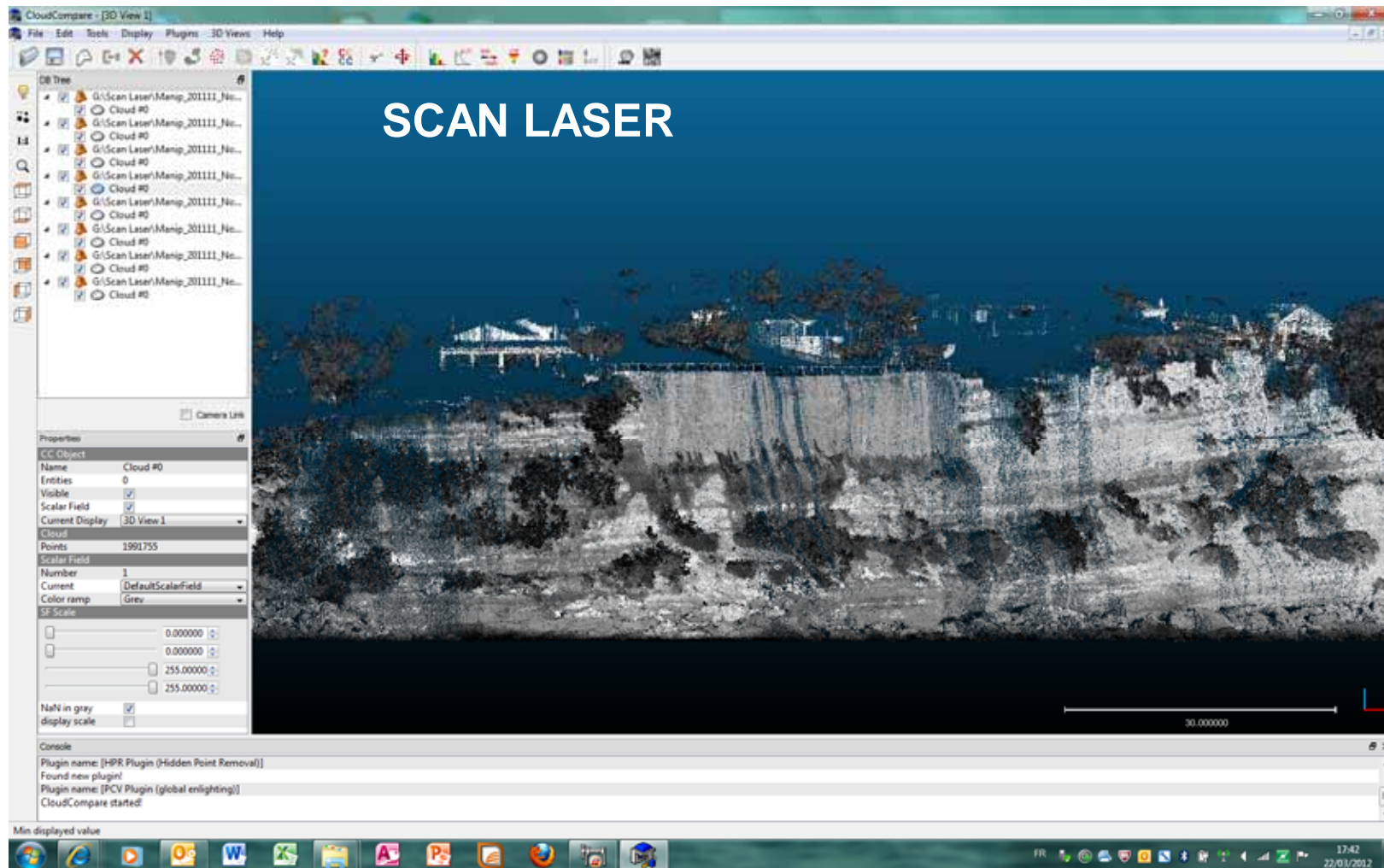
Working axes



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Cliff evolution monitoring



Cliff evolution monitoring



VALSE : Vulnérabilité et Adaptation pour Les Sociétés face aux Erosions de falaises côtières en région PACA



Levé Lidar des falaises depuis un bateau : Carry-le-Rouet (Bouches-du-Rhône)

CONTEXTE GENERAL ET OBJECTIFS

Les falaises du littoral de la région PACA s'effondrent régulièrement sans que l'on en comprenne exactement les circonstances. On ignore souvent quand les éboulements se produisent, suite à quels événements (périodes pluvieuses, forte houle, gel), quelles sont la taille et la forme de ces éboulements, et quels types de roches sont mobilisés. Soucieux d'améliorer les connaissances scientifiques pour pouvoir mieux gérer le risque, la Région PACA et le BRGM cofinancent le projet VALSE.

VALSE (Vulnérabilité et Adaptation pour Les Sociétés face aux Erosions de falaises côtières en région Provence Alpes Côte d'Azur) rassemble les laboratoires de recherche de la Région PACA : BRGM, CEREGE, GéoAzur et LPED pour cerner l'axe d'éboulement et comprendre comment les populations réagissent face à cet aléa. La DREAL PACA s'associe par ailleurs pour cofinancer avec la Région et le BRGM les levés Lidar présentés ici.

Les falaises de Carry-le-Rouet, suite à l'étude antérieure de Marçot N. (disponible en ligne à l'adresse : <http://www.brgm.fr/real/paca/brgm/>), apparaissent parmi les sites les plus exposés de la Région. C'est pourquoi des études plus poussées s'y déroulent depuis le début de l'année 2012.

Ce poster présente une coupe photographique des 3,5 km de falaises suivis tous les six mois par mesure photographique et lidar. Cette coupe, acquise les 30 novembre et 1er décembre 2012, montre la succession des couches géologiques allant du Sentier du Lézard à l'ouest au Cap de la Vierge à l'est de la commune, en passant par le Cap Roussat. Ce document sert à cartographier avec une précision de quelques centimètres les bancs qui constituent la falaise. Couplée à des observations géologiques de terrain, la coupe permettra de déterminer la nature précise des roches dont l'éboulement aura été observé par les campagnes de mesure successives. Celle de juillet 2012 a déjà été acquise, elle sera suivie de trois autres levés entre fin 2012 et fin 2013.



Source BRGM

Données : Valérie Lecomte
BRGM - Centre National de Géodésie
VALSE - PACA - BRGM - CEREGE - GéoAZUR - LPED



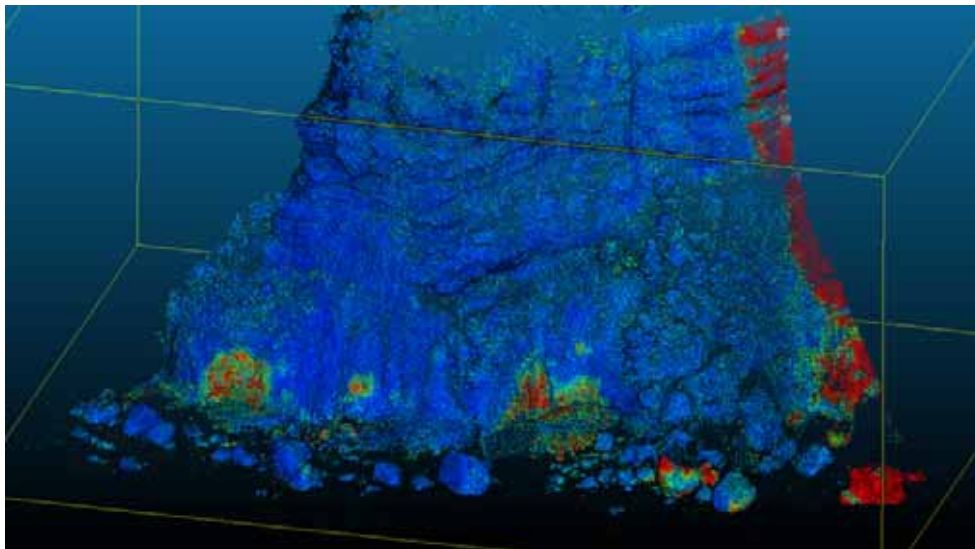
Cliff evolution monitoring



Small scale analysis

Dynamique d'érosion haute résolution spatiale – court terme

- scan laser dynamique terrestre sur les falaises (Carry le Rouet, 13) ;
- analyse fine de la dynamique des falaises ;
- instrumentation in situ associée (station météo, mesure résistivité, photogrammétrie).



Exemple d'érosion en base du Cap de la Vierge (nuage de point 2011)

Travaux en cours



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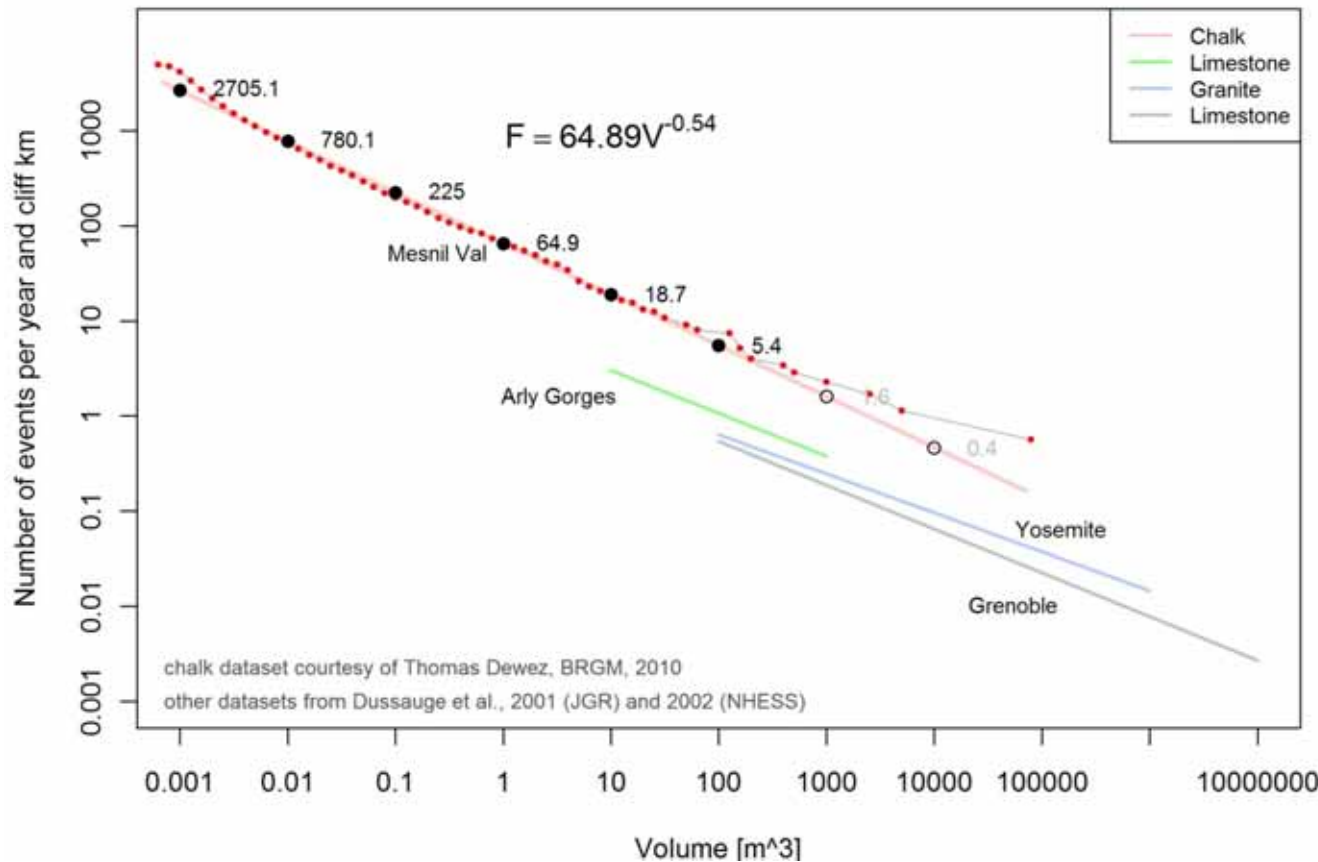
Cliff evolution monitoring



Objectives

Probabilistic law determination

Etudes statistiques / historiques sur les éboulements
 Divers auteurs ont proposé des relations du type $F = aV^b$ avec F fréquence; b constante ($0,55 \pm 0,15$); a nb d'événement $> 1m^3$



Exemple Normandie

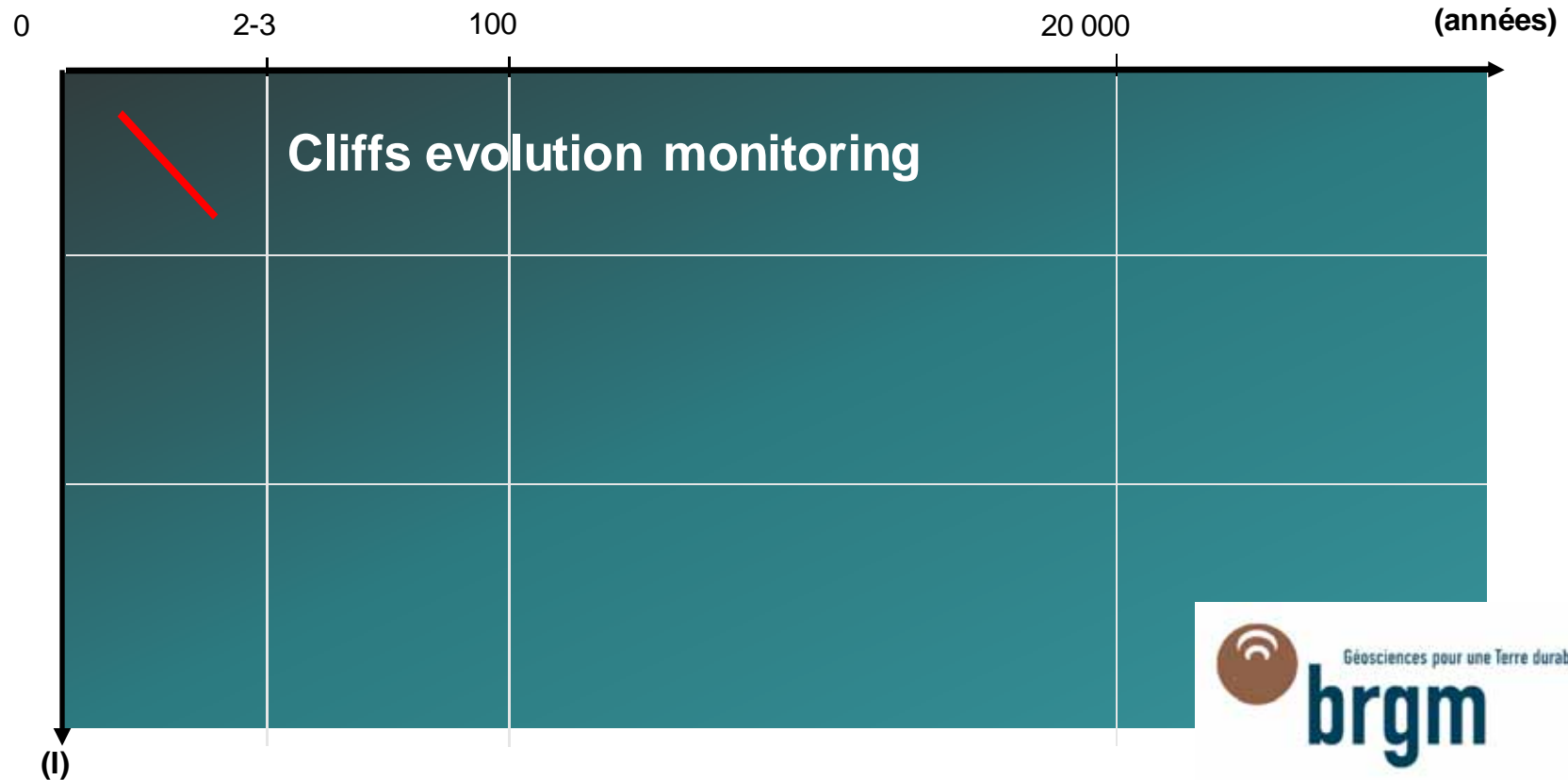
Dewez, BRGM 2010



Working axes



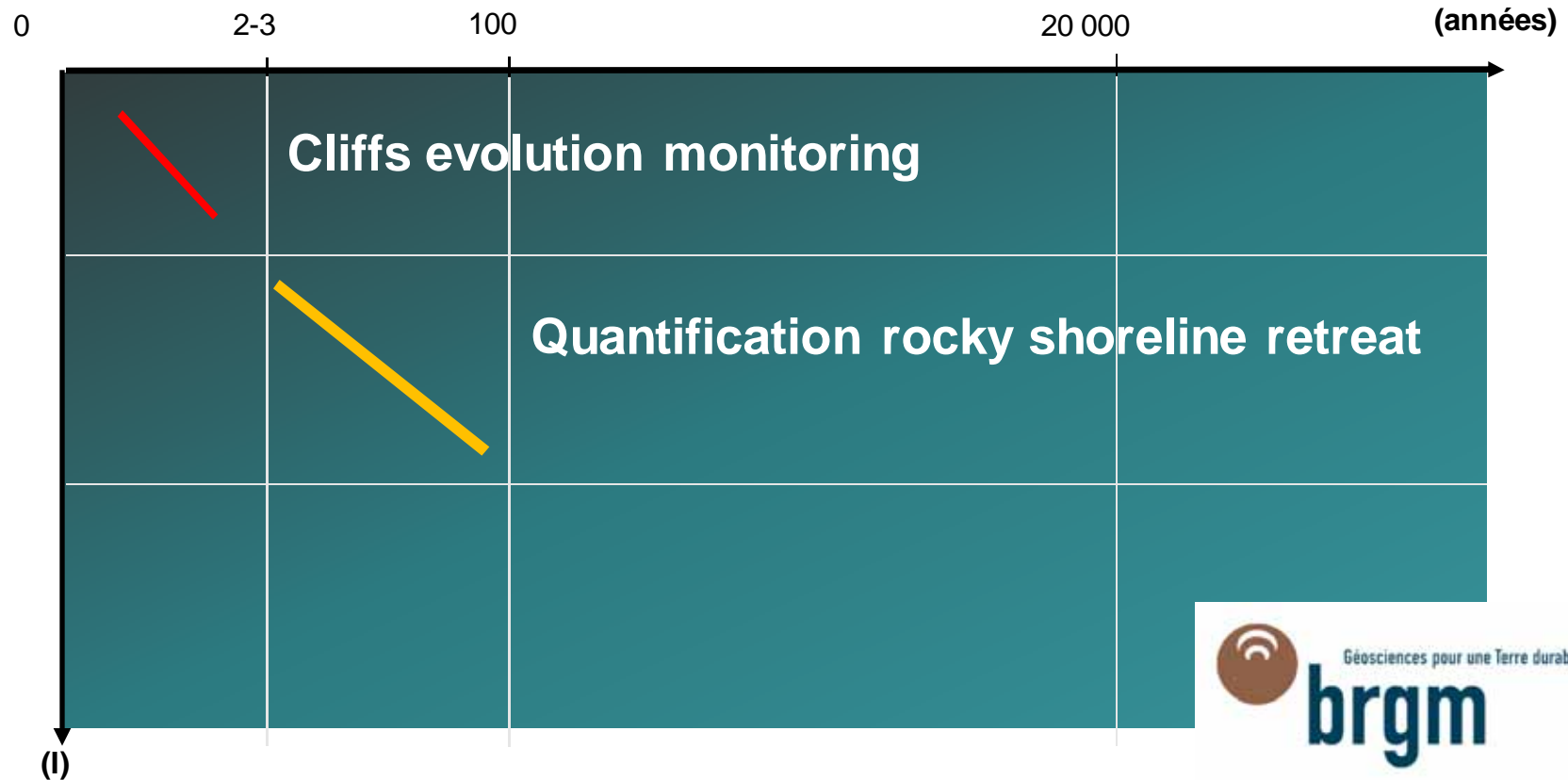
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Working axes



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Rocky shoreline retreat



1. Shoreline morphology analysis

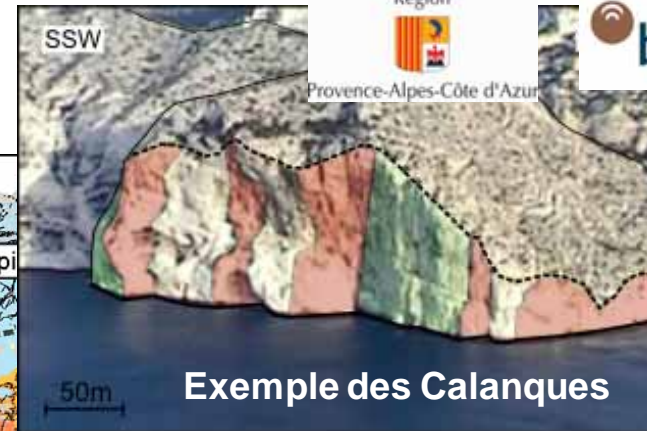
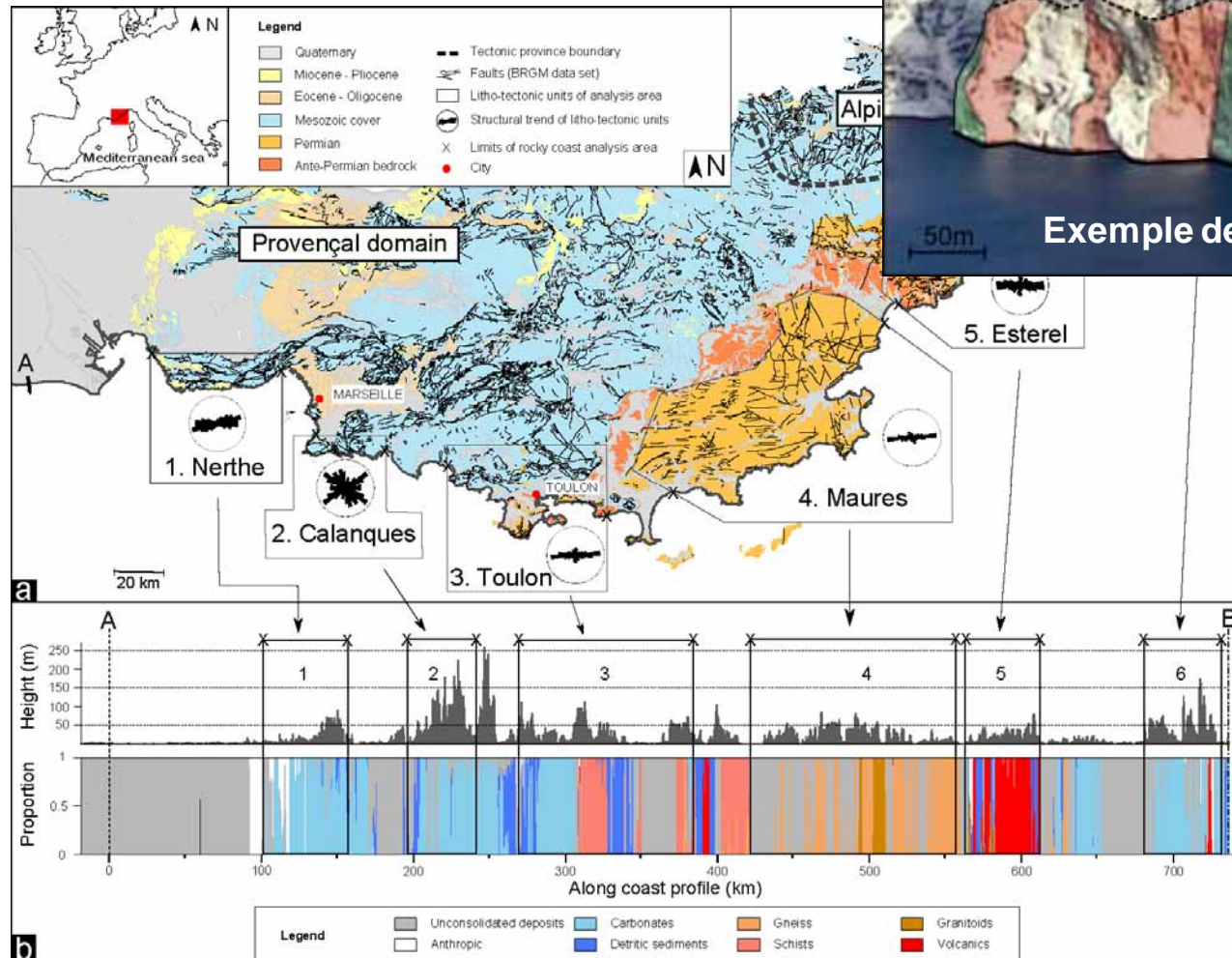
2. Secular coastal erosion analysis



Shoreline morphology analysis



Geological context



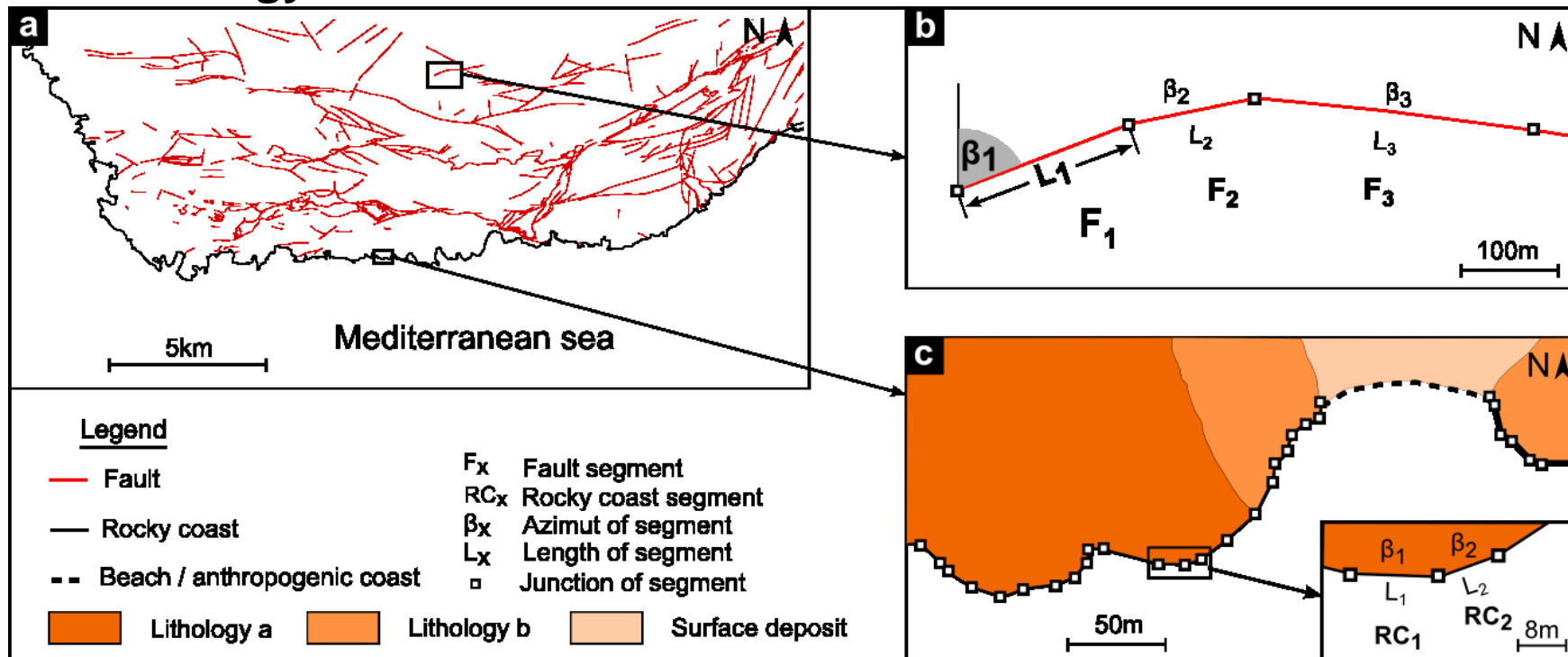
Giuliano et al., 2013



Shoreline morphology analysis



Methodology



Giuliano et al., 2013

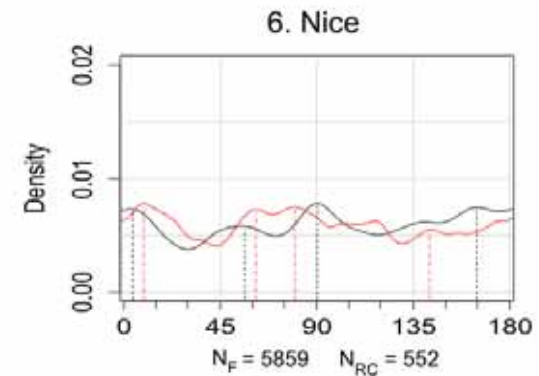
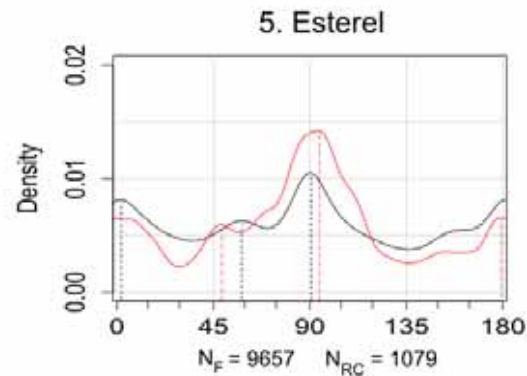
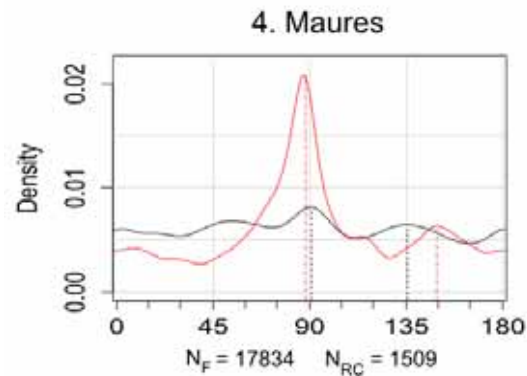
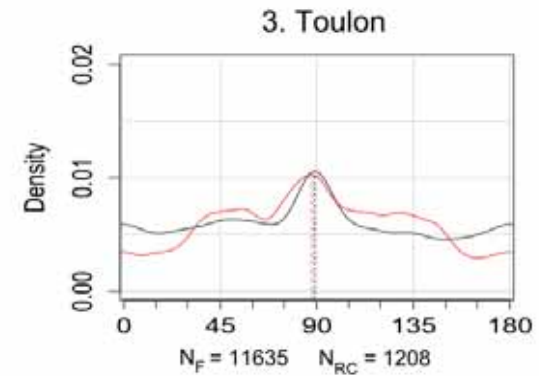
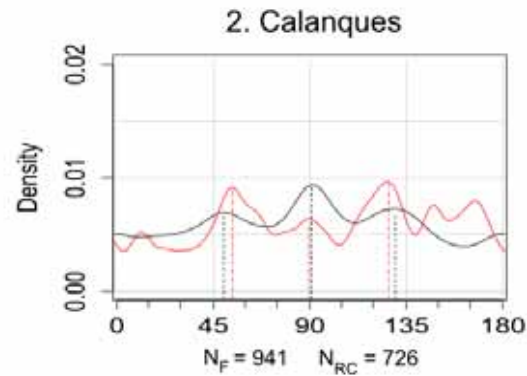
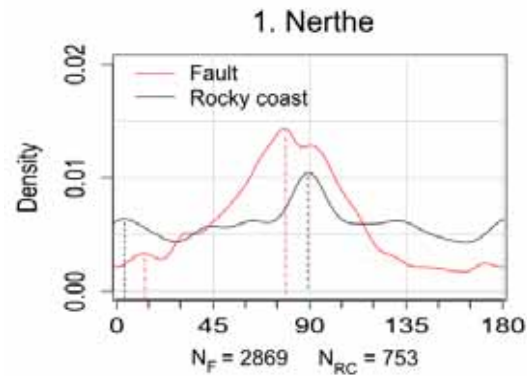
- a : exemple zone de la Nerthe (Bouches-du-Rhône) ;
- b : azimut et longueur de chaque segment de faille ;
- c : idem segments rocheux du littoral (hors plages et tronçons anthropiques)



Shoreline morphology analysis



Results and interpretations



Giuliano et al., 2013



Shoreline morphology analysis



Results and interpretations

Morphological of rocky coastline : structural control

(Giuliano et al., Journal of Coastal Research)

- **Structural control : E-W fault ;**
- **Low control in Maures sector (metamorphic domain).**



Rocky shoreline retreat



1. Shoreline morphology analysis


2. Secular coastal erosion analysis



Secular coastal erosion analysis (ortho-photos : 1924-1998)



General notions

Methodology :  Observation of 2 diachronic sets of ortho-photos
Comparison of shoreline position (base or/and head of cliff)

Methodology characteristics

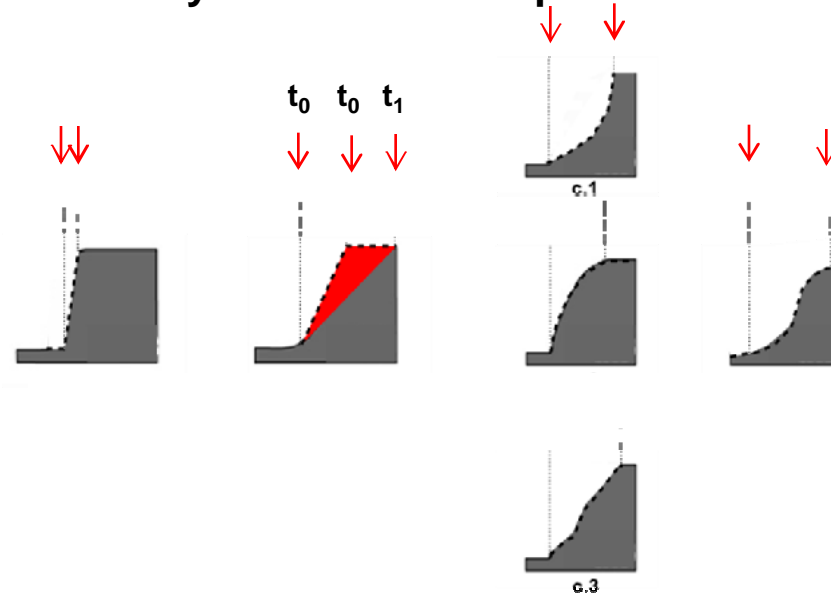
- Classical methodology
- Usually used to estimate a rate of erosion

3 stages :

- 1/ Definition of the studied object
- 2/ Geography-referencing and covering
- 3/ GIS analysis

(Glasse et al., 2003 ; Dornbush et al., 2008 ; Thielert et al., 2009 ; Brooks et Spencer, 2010)

Synthesis of cliffs profiles

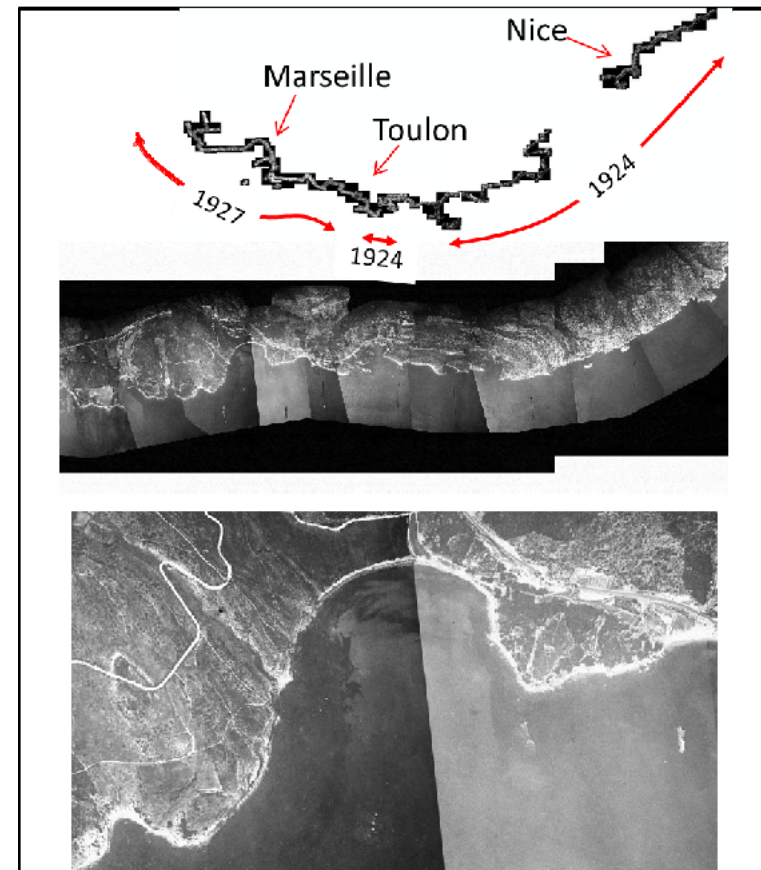
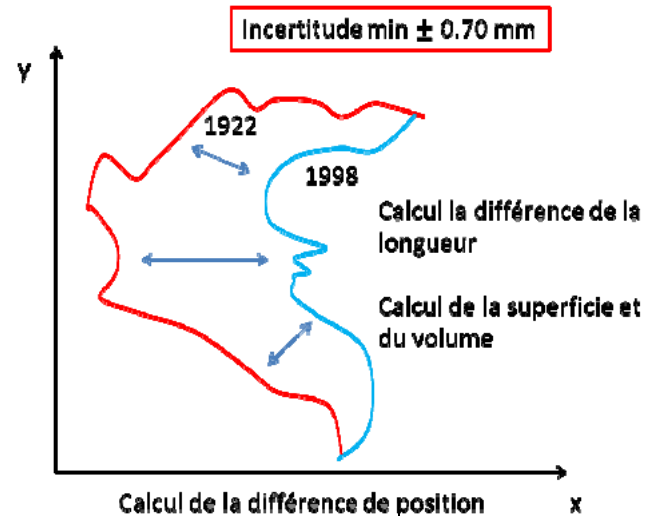


(Brooks et Spencer, 2010 ; Del Rio et al., 2009 ; Nunes et al., 2009 ; Dupperet et al., 2005 ; Korgure et al., 2005)

Secular coastal erosion analysis (ortho-photos : 1924-1998)



Methodologie – limits - uncertainties



- Decalages and deformations ;
- Old pictures quality very variable ;
- Distorsion ;
- Problems of ortho-rectification ;
- Problems of angles of view ;
- Uncertainty of the digitized line

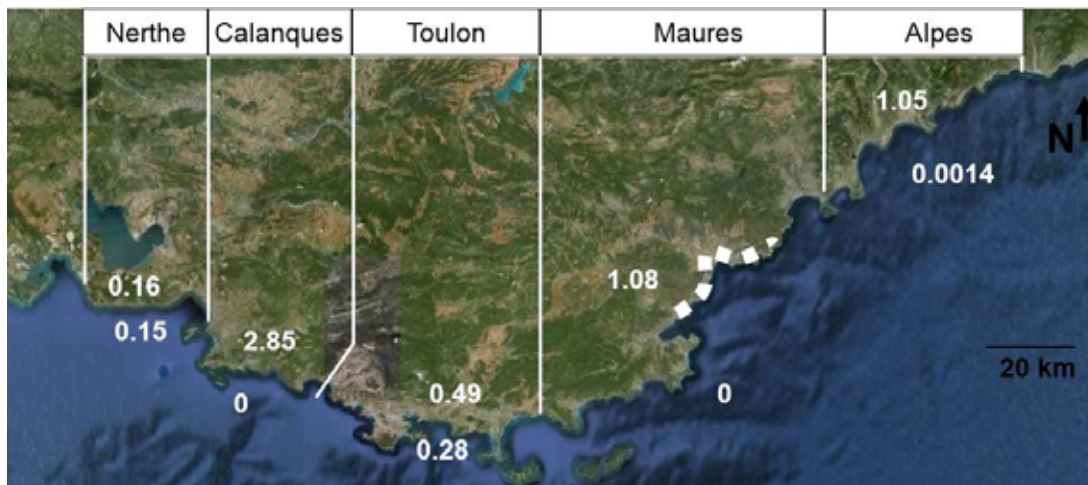
Secular coastal erosion analysis (ortho-photos : 1924-1998)



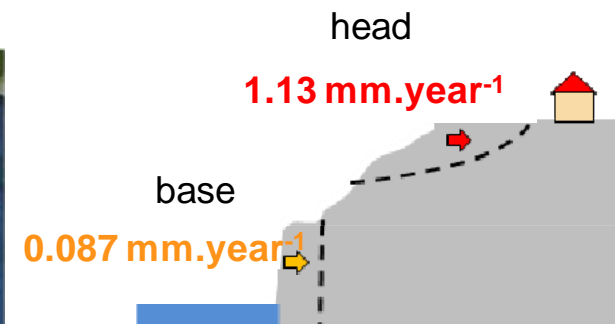
Results

Shoreline dynamical at secular scale : low erosion rate

- Erosion analysis with ortho-photography (CRIGE PACA) ;
- Low means retreat over 80 years ($\sim \text{mm}\cdot\text{year}^{-1}$) ;
- Head of cliff erosion more important → dominance of subaerial processes



a – Erosion rate ($\text{mm}\cdot\text{year}^{-1}$) by litho-structural unity



b- Means regional erosion rate



Secular coastal erosion analysis (ortho-photos : 1924-1998)



Reflexion

Questions :

- Volume et fréquence ?**
- Constant evolution ?**
- Pulse ?**
- Temporal windows ?**
- Links with global eustatic variations ?**

(Parham et al., 2006)

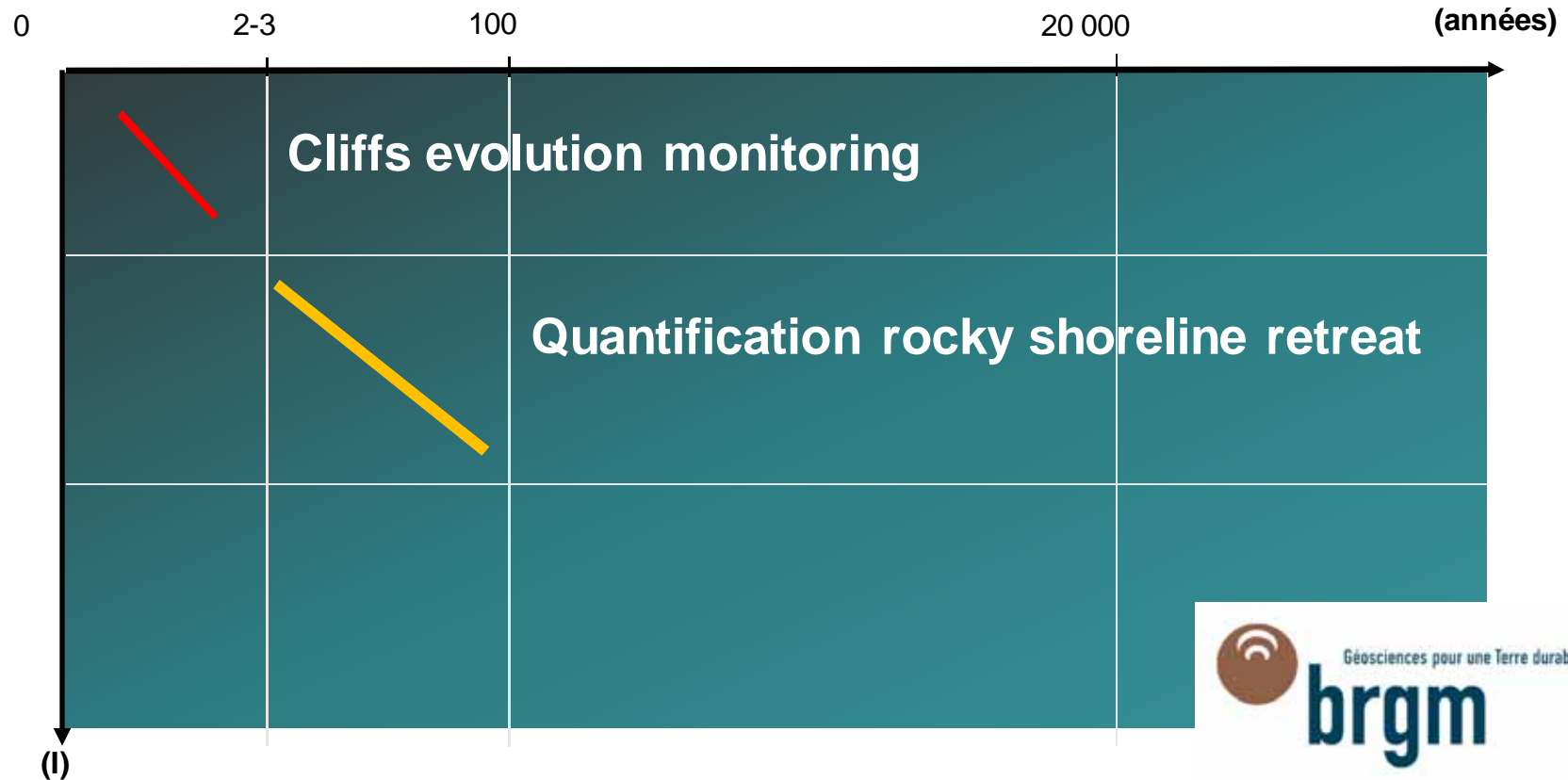
Current works



Working axes



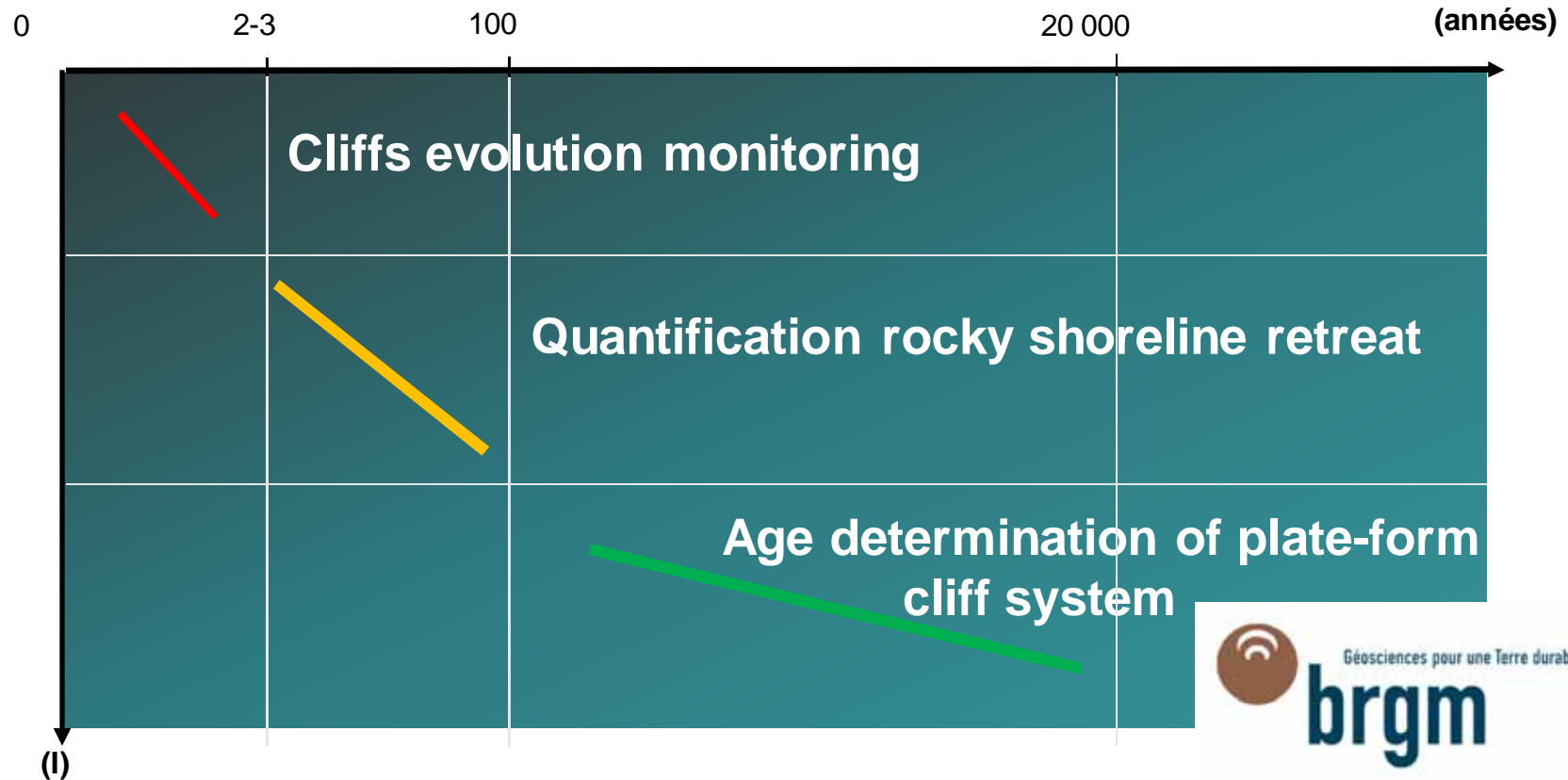
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Working axes



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Age determination of platform / cliff system



Modern platform



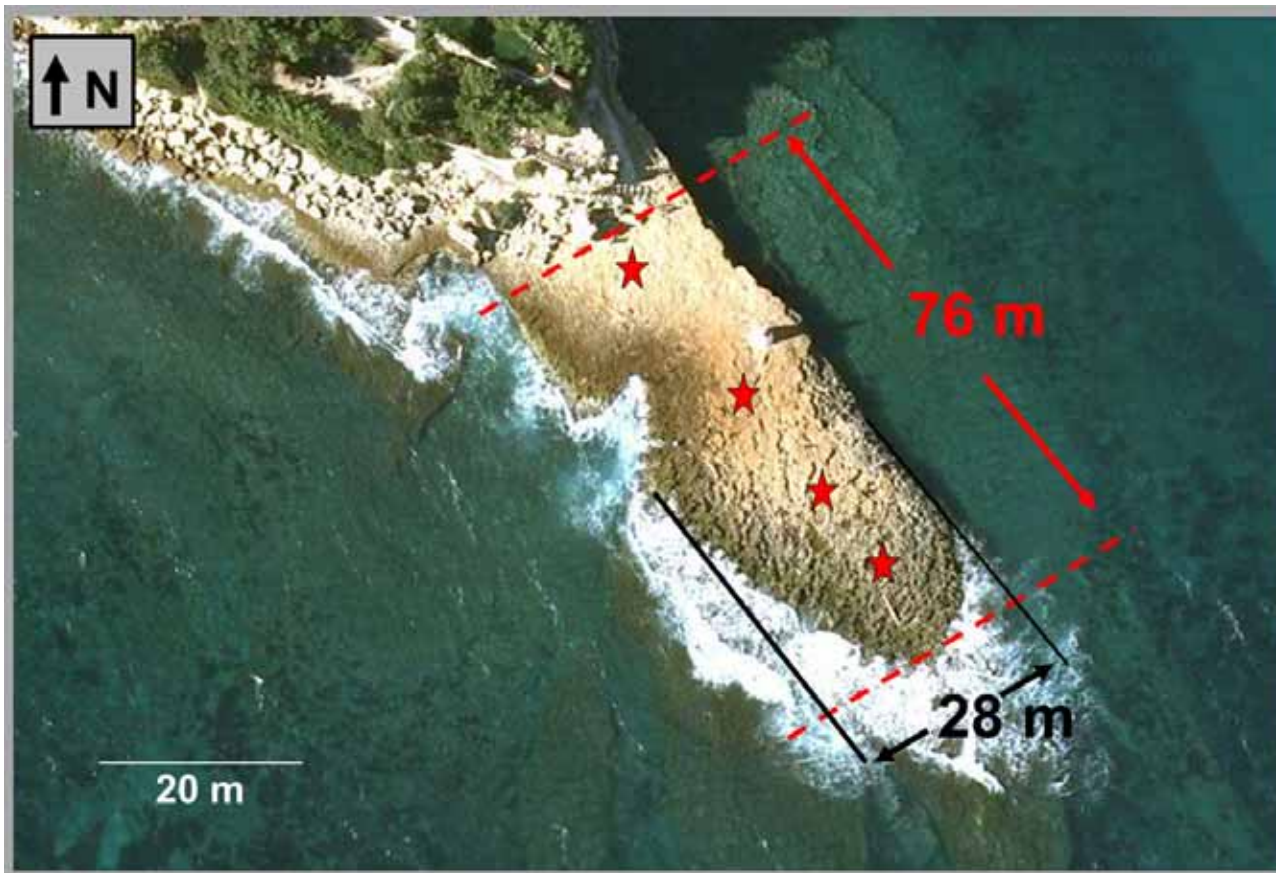
Port de Carry le Rouet



Age determination of platform / cliff system



Modern platform



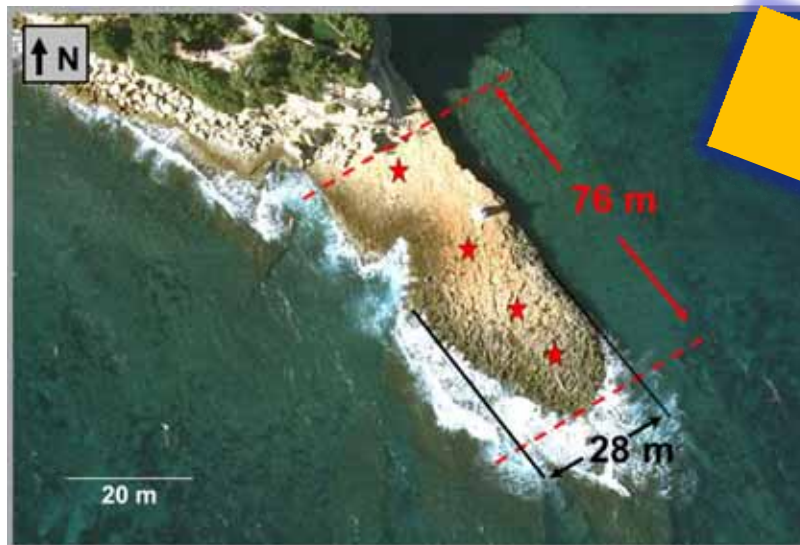
Age determination of platform / cliff system



Small scale analysis

Dynamique d'érosion long terme plateforme-falaise (Quaternaire)

- continuité des travaux V. Regard, T. Dewez, D. Boulès et al (2012) sur le ^{10}Be en Normandie ;
- datation ^{36}Cl sur les platiers carbonaté Côte Bleue (10 en cours de test) ;
- quantification de l'évolution de la vitesse érosion (Quaternaire).



a- Echantillonnage sur platier contemporain (Carry le Rouet, 13)

Current works



b- ASTER – CEREGE (Aix en Provence, 13)



Age determination of platform / cliff system



Old quaternary platform



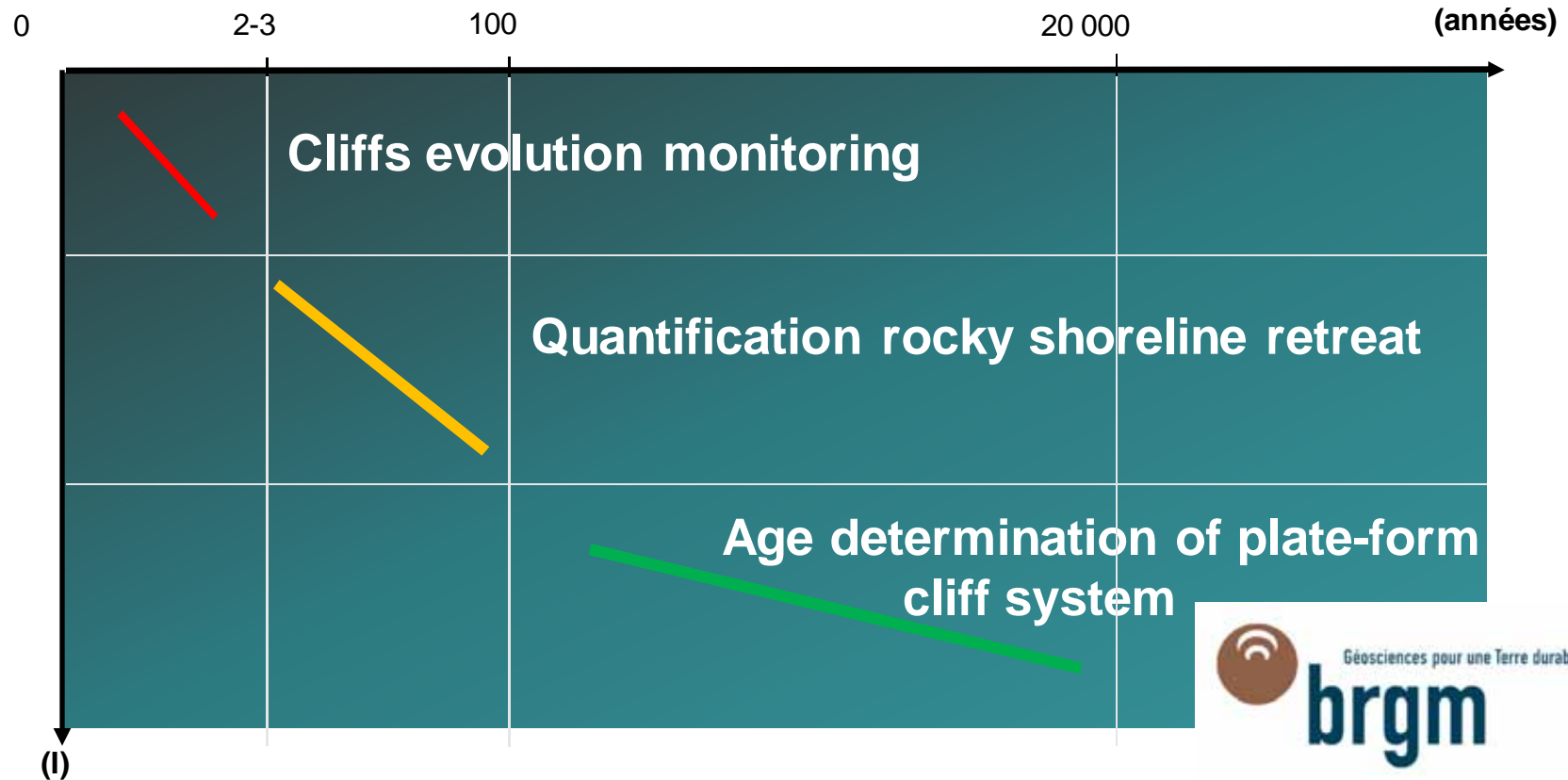
Marqueurs d'origine marine
Calibrage de la méthode avec
datation des balanes



Working axes



Title : « Multi-temporal and multi-scale mechanism of coastline cliff evolution in PACA region, and more particularly in Côte Bleue (13) »



Axes de travail



Respect multi-scale in time and in space :

- 3 timing scale : year, century, holocène
- 3 space scale : region, city, local site

Relations between space scales and time ?

