Aristotle University of Thessaloniki

Training Networking and capacity building for sustainable forestry in Povolgie

Case study: Ecological and visual impact assessment of marble quarry expansion (1984-2000) on the landscape of Thasos island, NE Greece

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Specific Objectives

- To identify marble quarry expansion between 1984 - 2000 on the island of Thasos by change detection.

- To quantify and assess the visual, ecological and landscape impact.

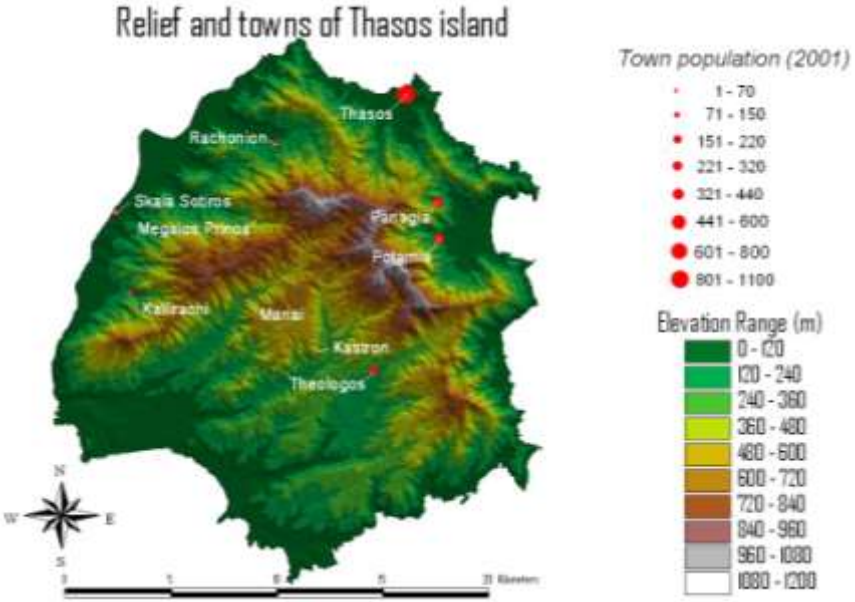
Study area

The study area is the island of Thasos in NE Greece. Its surface area is 383 sq. km while its perimeter is approximately 128 Km. Elevation ranges from 0 to 1200 m; slopes range from 0 to 80 degrees.

Environmental threats:

- **Forest fires** in 1984, 1985, 1989 and 2000 have burned 47% the island in the past. 75% of the area burned has been *Pinus brutia* and *Pinus nigra* forests that represent the climax vegetation type of the island.

- **Escalating marble quarrying activity** having ecological effects (destruction of vegetation cover) and visual effects (degradation of landscape aesthetics).



Datasets

- **Satellite data**:
  - Landsat TM and ETM+ images (1984, 2000)
- **Digital Elevation Model**
- **Landcover map** produced from ortho-photos (1984)
- **Field data:**
  - GPS data to validate quarry detection

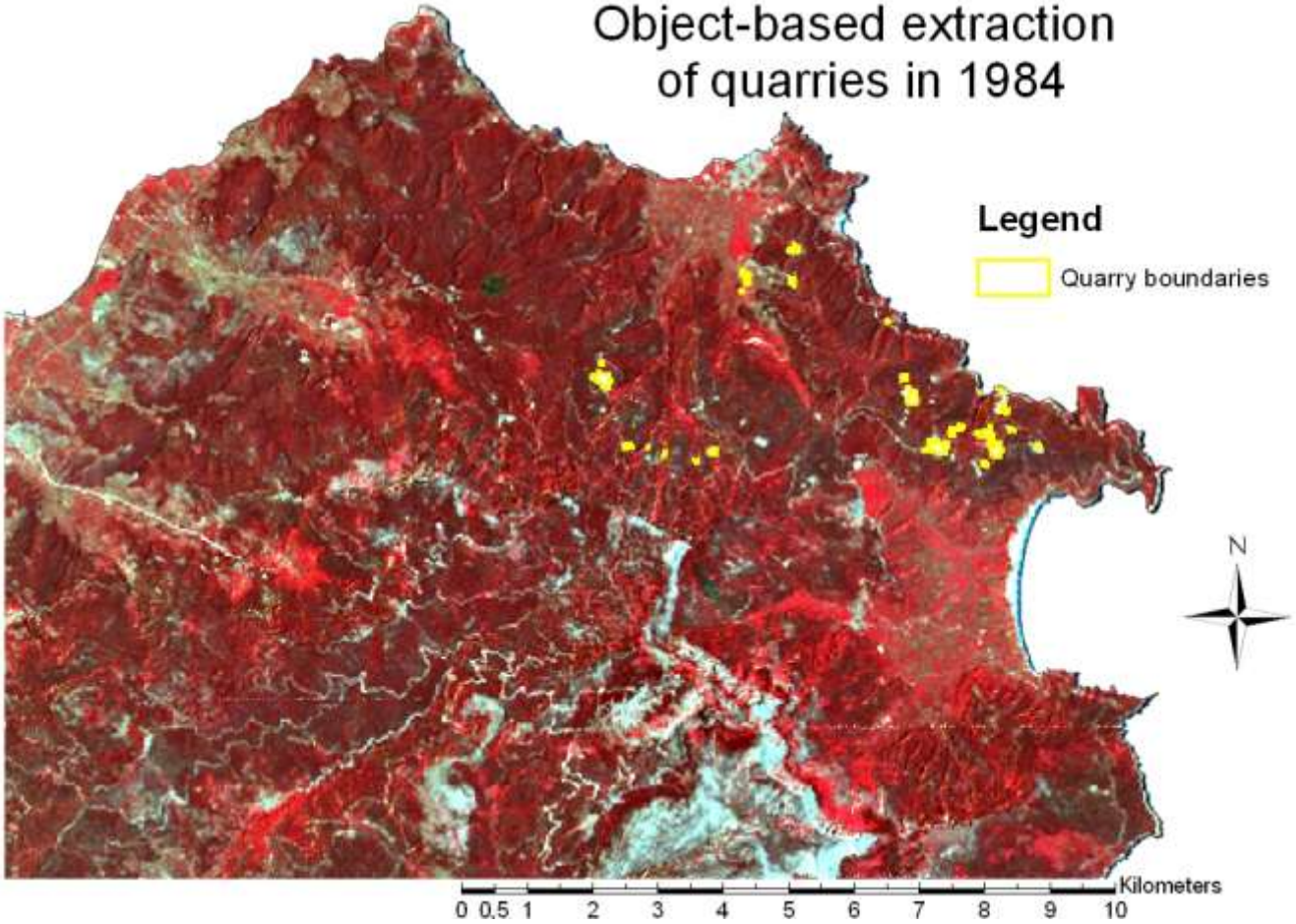
Methodology

1. Assessment of quarries **extent** and **expansion** employing change detection techniques.

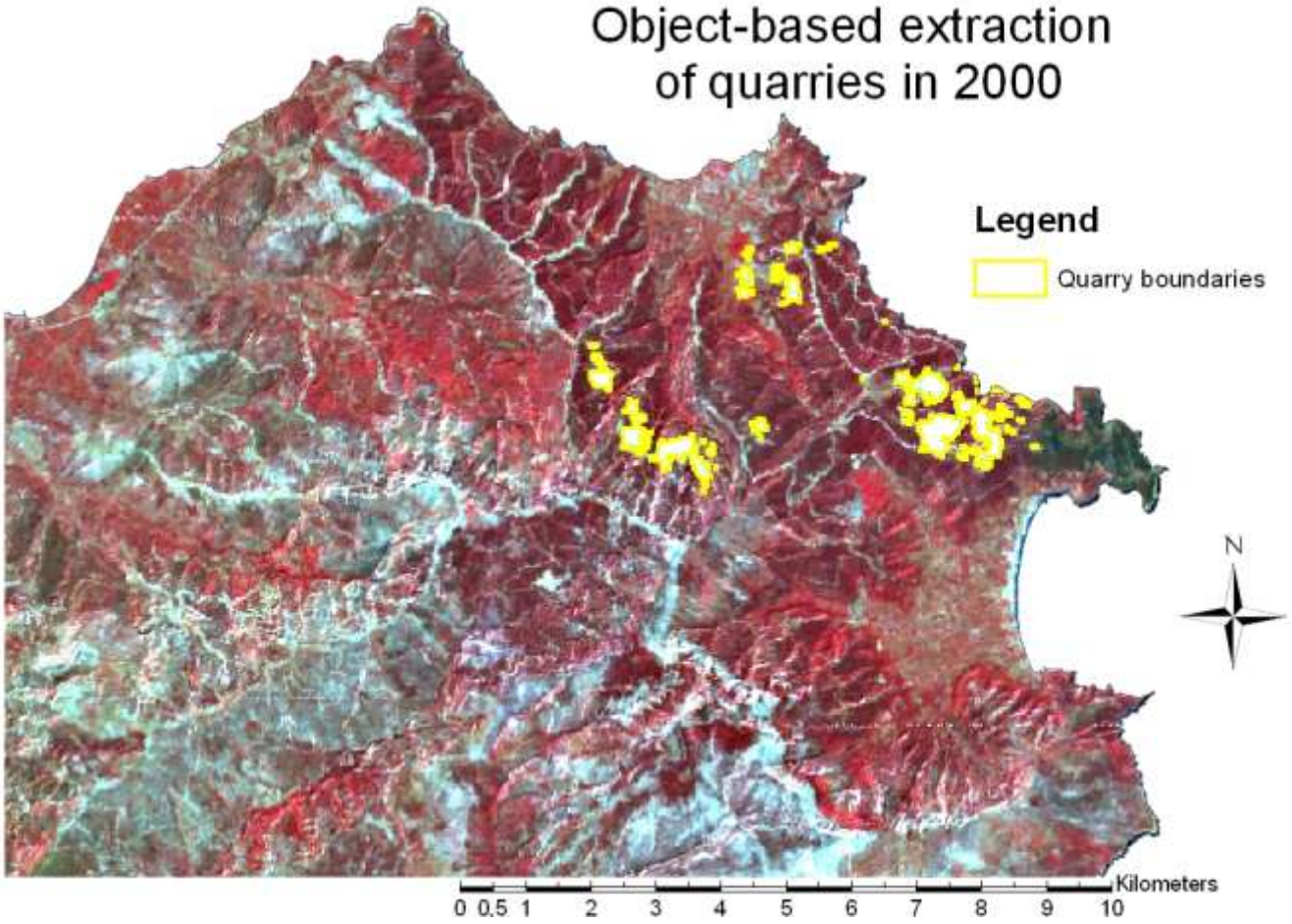
2. Derivation of **landscape metrics** of quarries.

3. Quarry **viewshed analysis**.

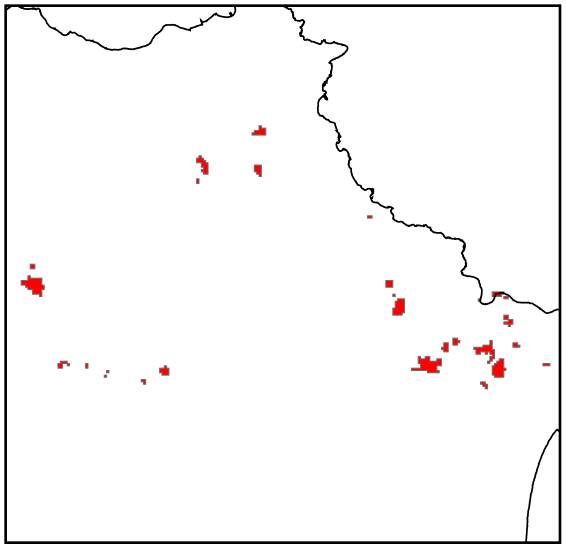
1- Assessment of quarries **extent** and **expansion**.



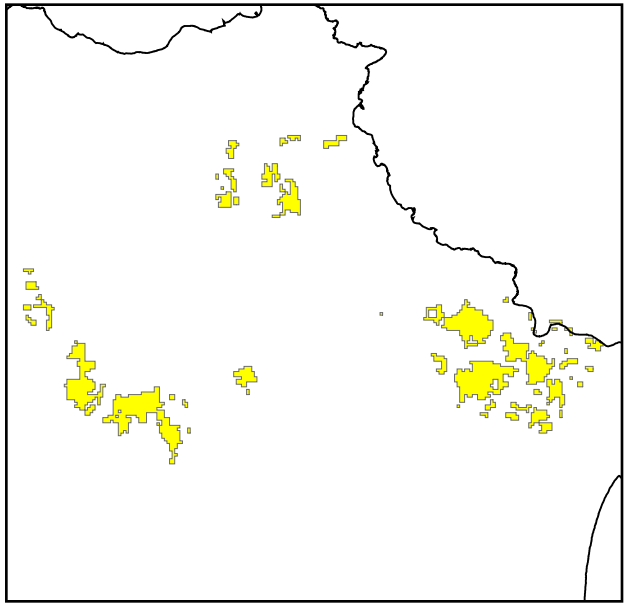
1- Assessment of quarries **extent** and **expansion.**



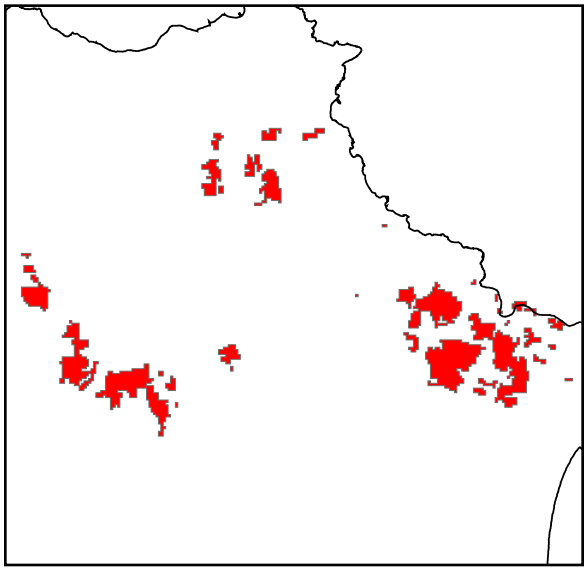
Post classification comparison



Quarries 1984



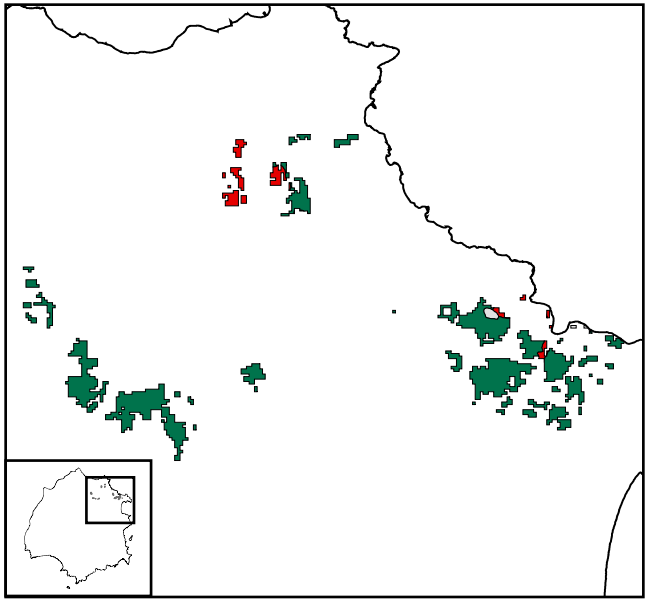
Expansion map



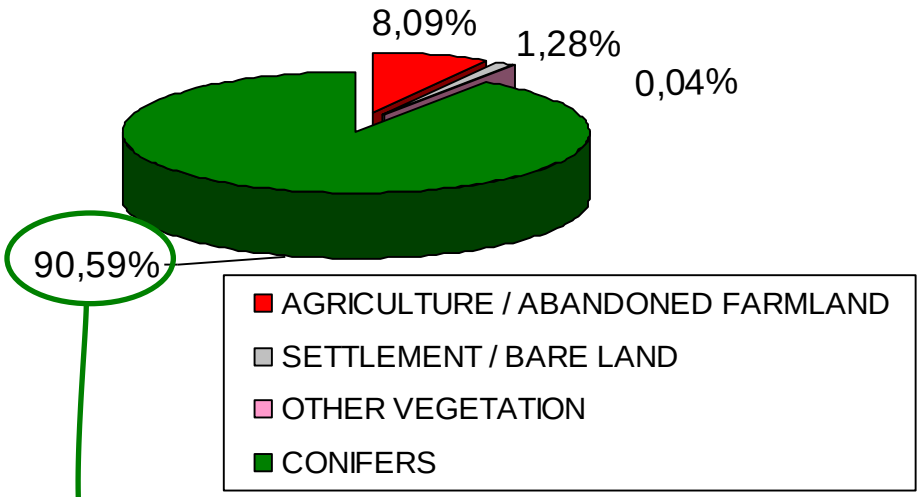
Quarries 2000

2- Ecological impact

What land cover are quarries replacing?



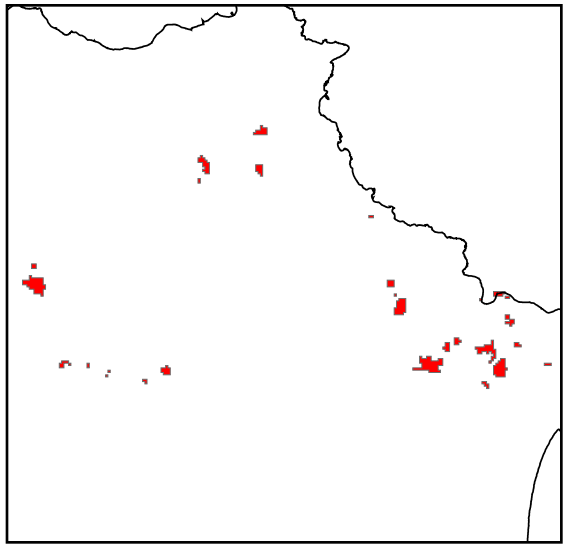
AGRICULTURE / ABANDONED FARMLAND
CONIFERS
DECIDUOUS
OTHER VEGETATION
SETTLEMENT / BARE LAND



Quarries are expanding mainly into areas previously covered by pine forest

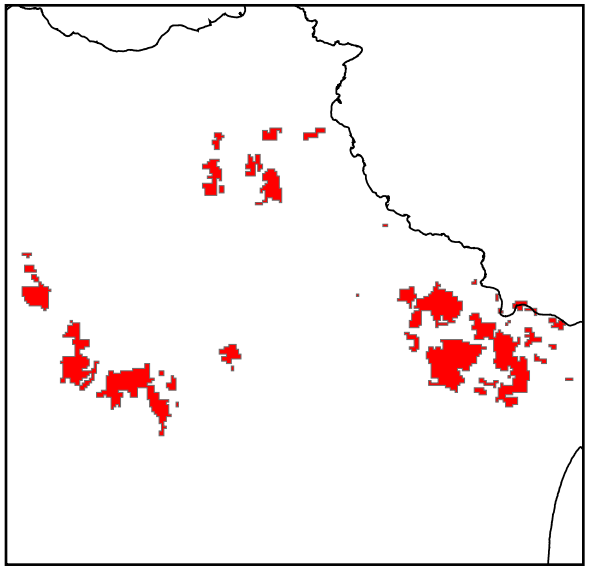
2- Landscape impact

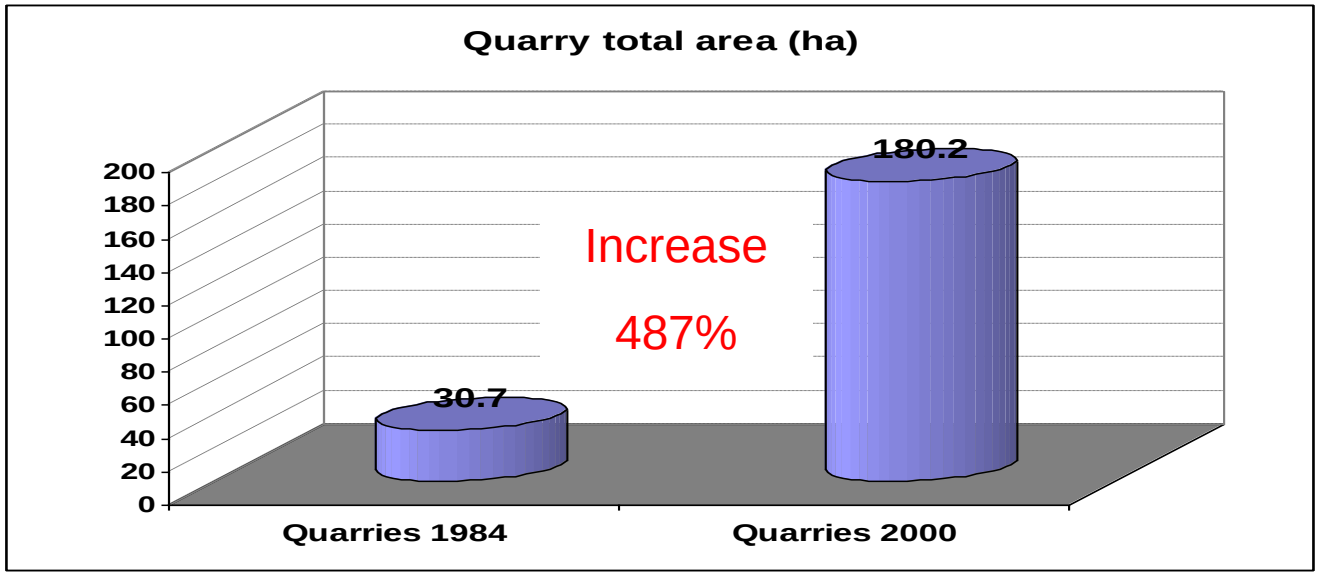
Quarries 1984



16 years

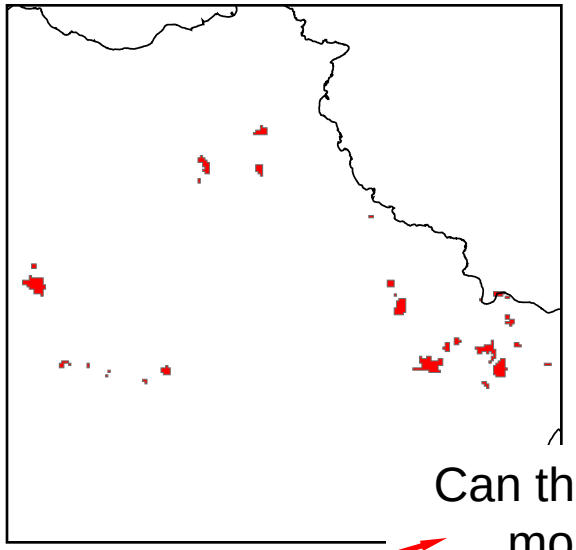
Quarries 2000





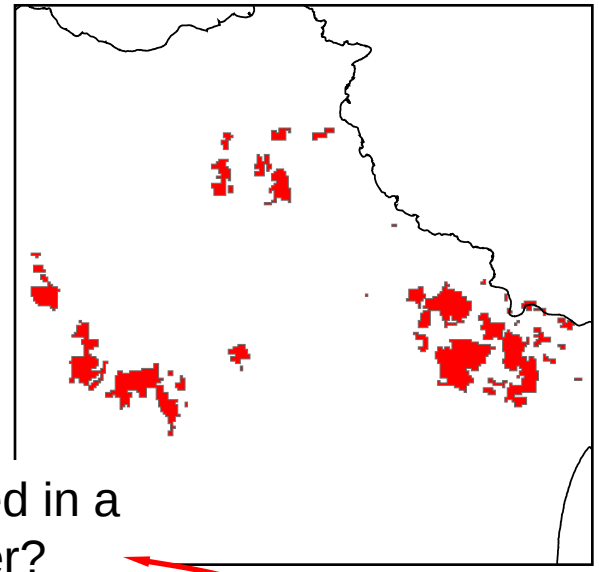
2- Landscape impact

Quarries 1984

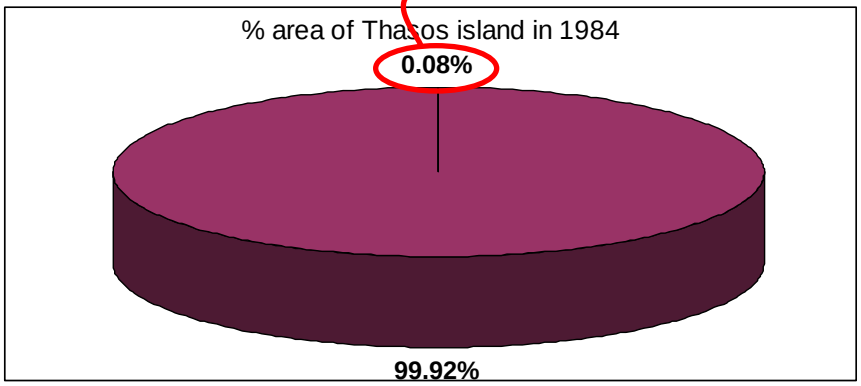


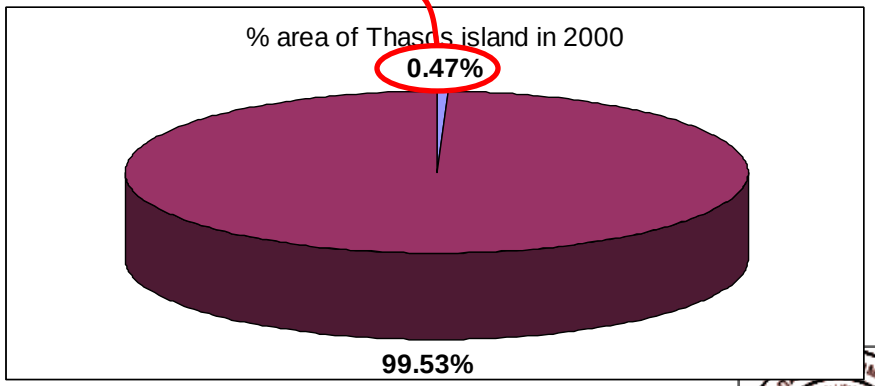
16 years

Quarries 2000



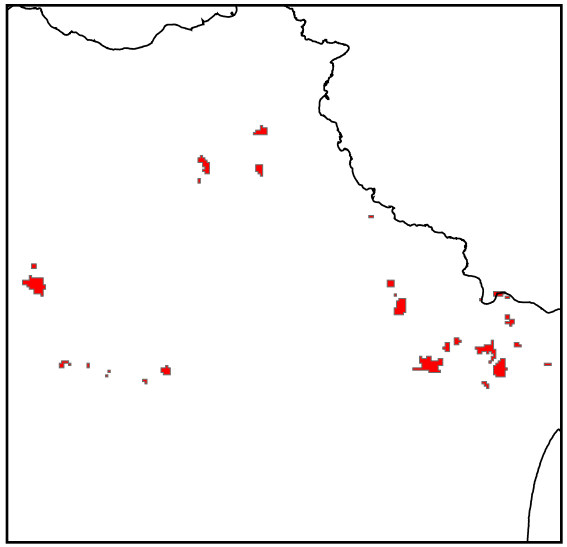
Can the impact be measured in a more meaningful manner?





2- Landscape impact

Quarries 1984



16 years

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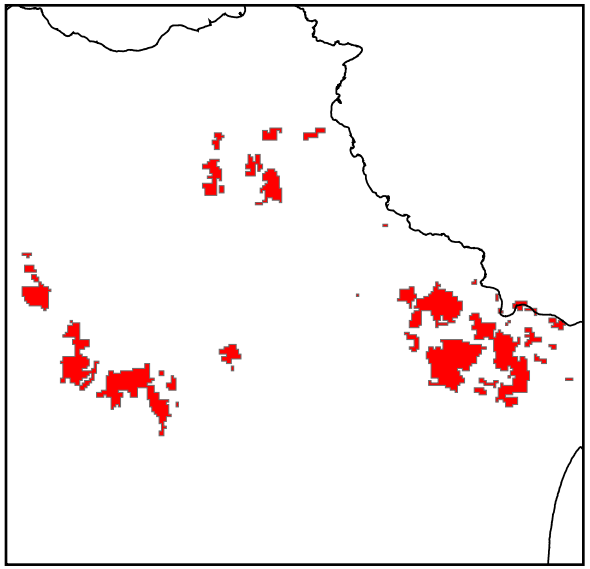
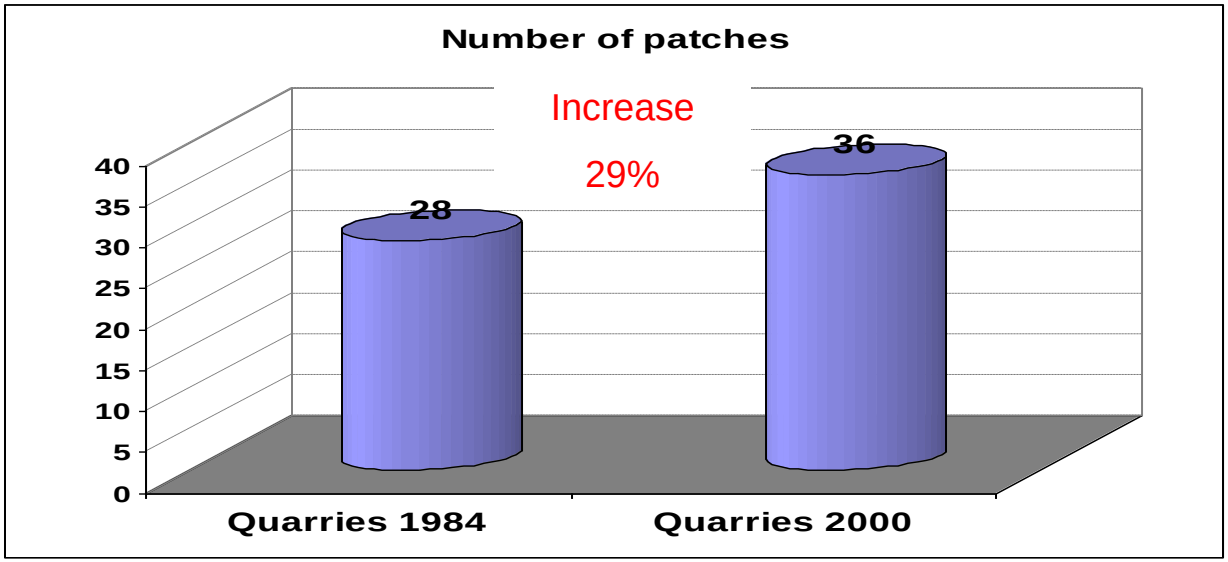
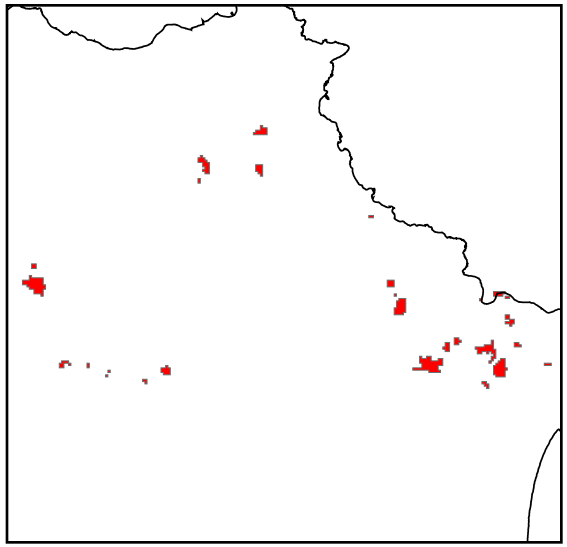




8 new quarries were created

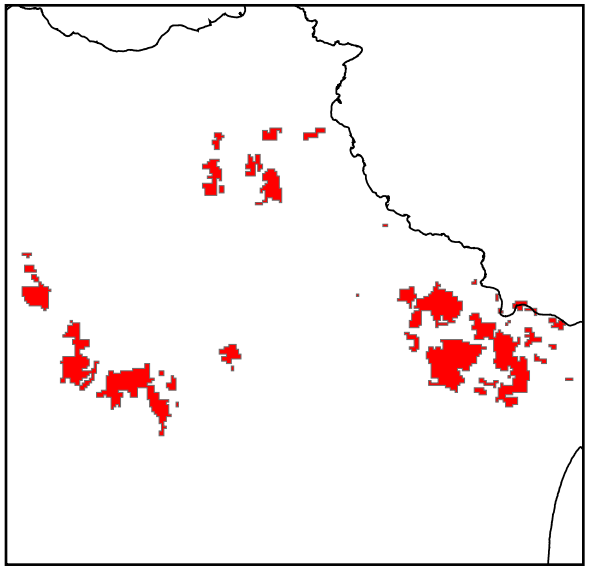
2- Landscape impact

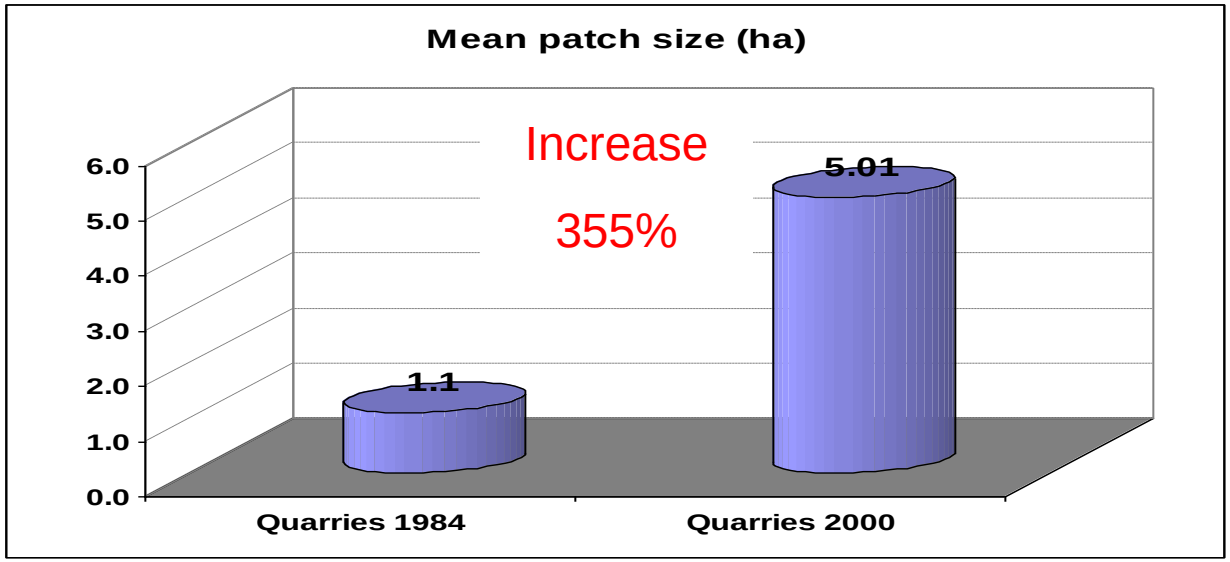
Quarries 1984



16 years

Quarries 2000

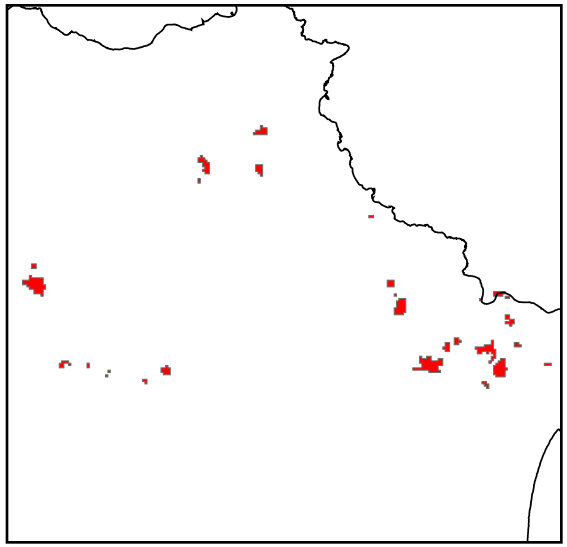




Quarries were enlarged from ~1ha to ~5ha on average

2- Landscape impact

Quarries 1984



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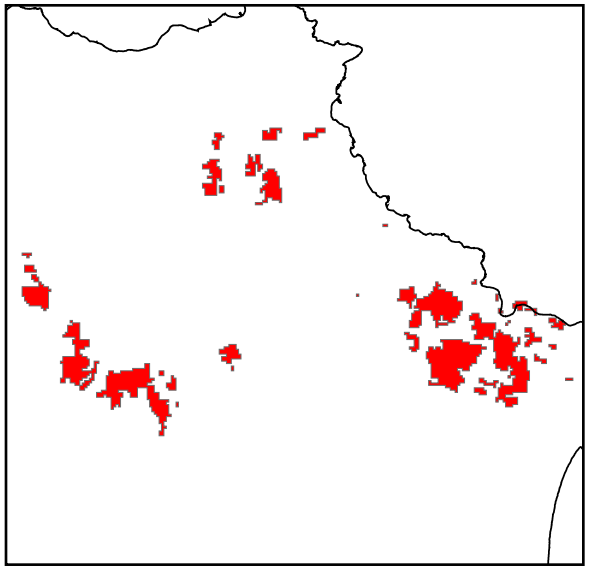
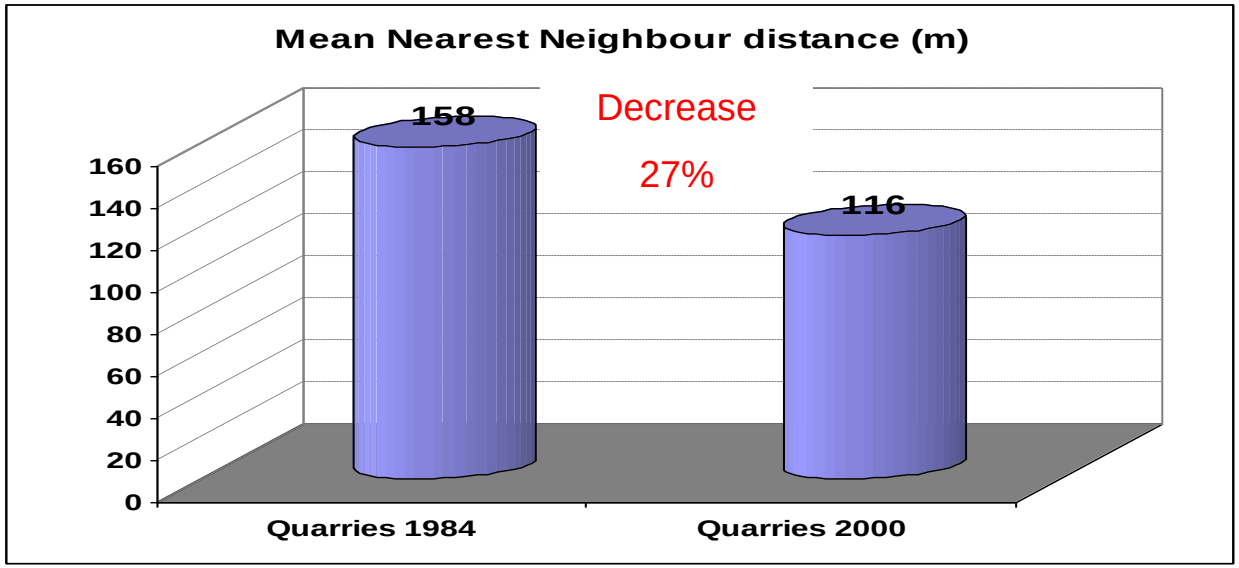
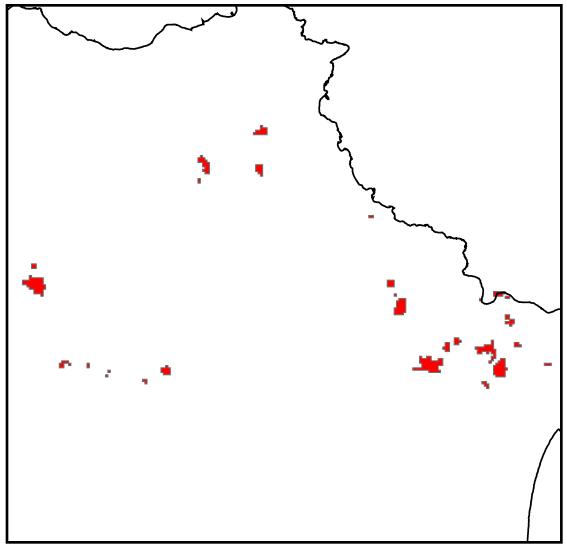




Quarries in 2000 are closer to each other

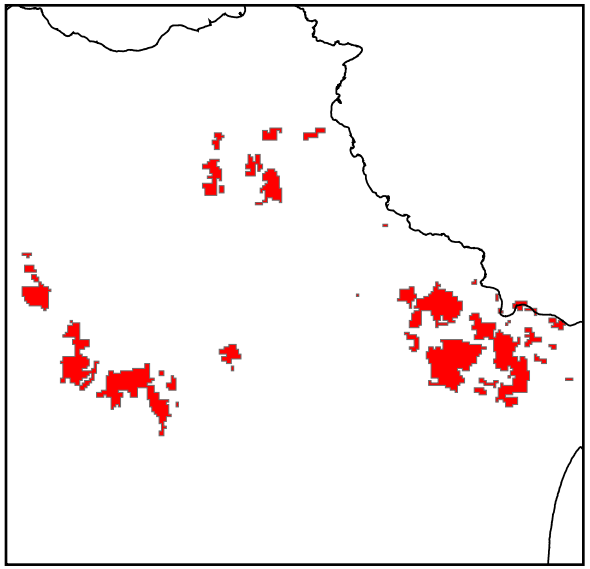
2- Landscape impact

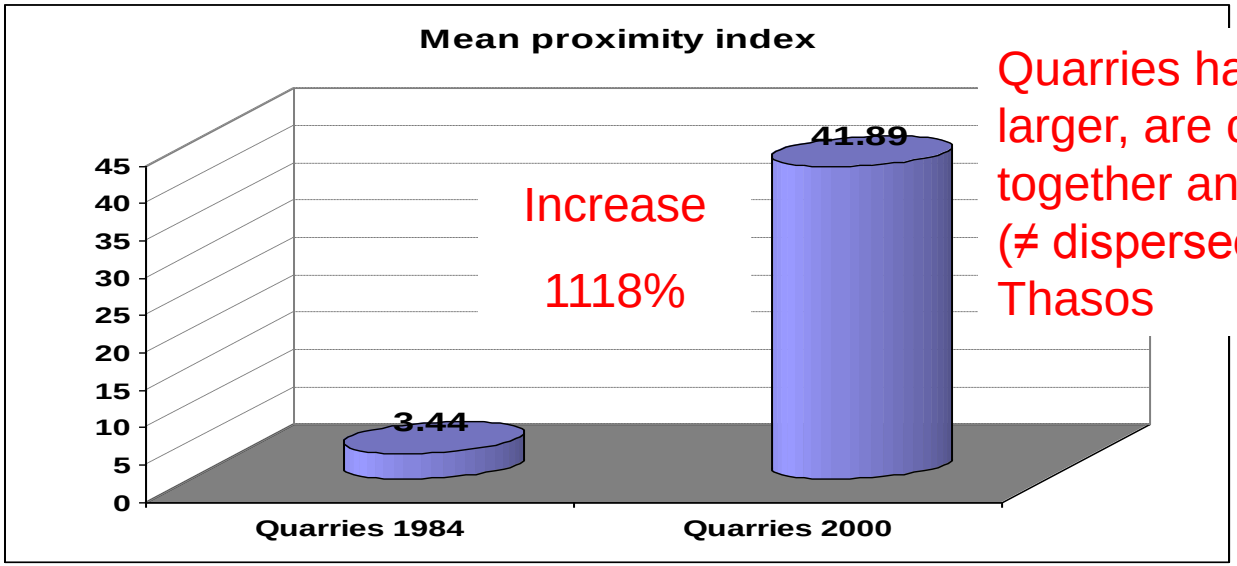
Quarries 1984



16 years

Quarries 2000





Quarries have become larger, are closer together and aggregated (≠ dispersed) in NE Thasos

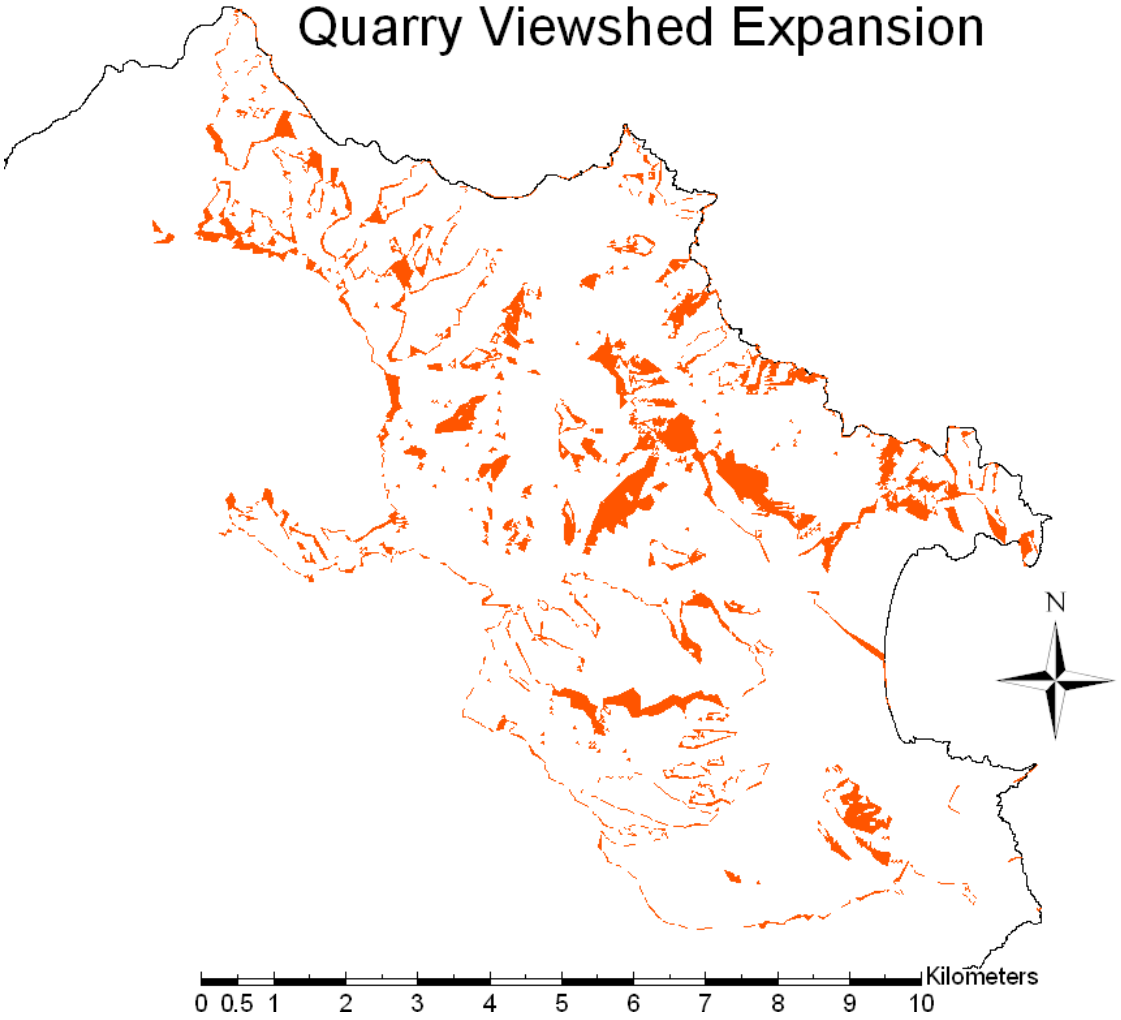
2- Ecological, landscape and visual impact








Visual impact



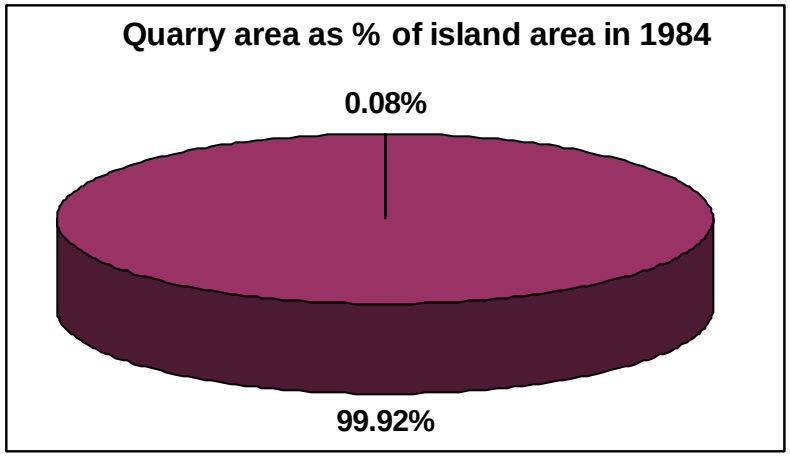
- In which areas of the island will an observer be able to see at least one pixel of marble quarry?
  - BUT how intense is this visual impact (how many quarry pixels are seen in each location)?
    This is answered later.
    Lets first consider the expansion of the viewshed.

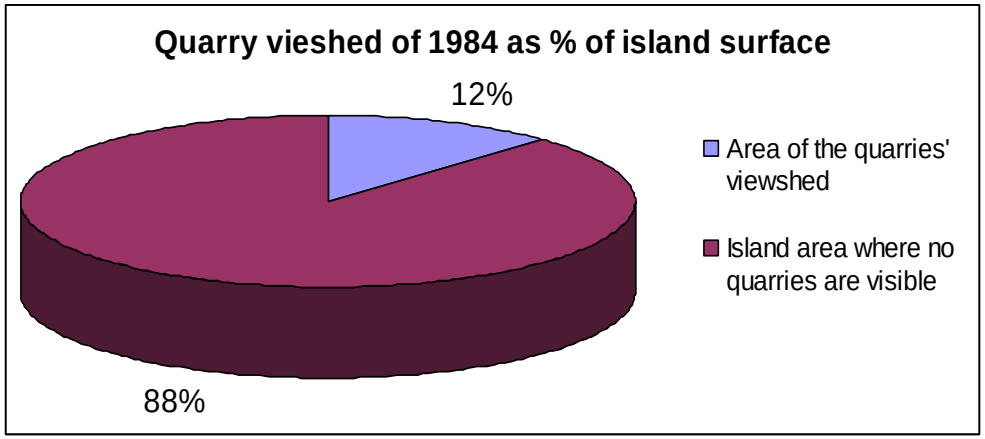
Visual impact

	1984	2000
Viewshed area of marble quarries (ha)	**4699.53**	**5179.86**
Viewshed area as % of island surface	**12.29%**	**13.54%**

Notice the more realistic percentage of the area of the island affected visually by quarries.

In 1984 quarries took up 0.08% of the island but affected visually 12% of the island



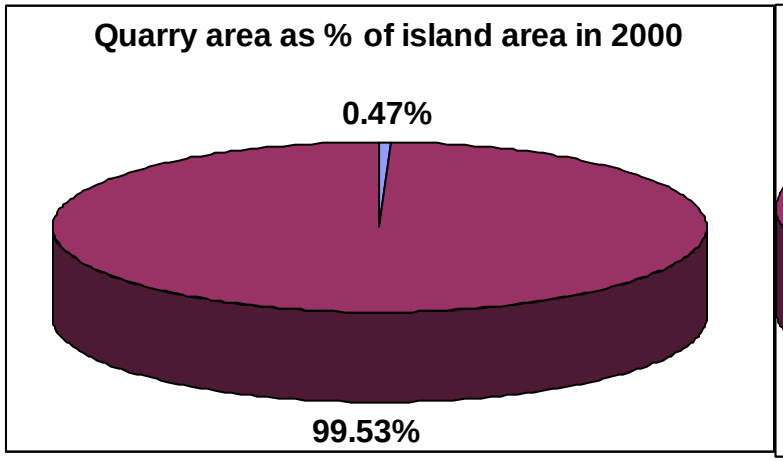


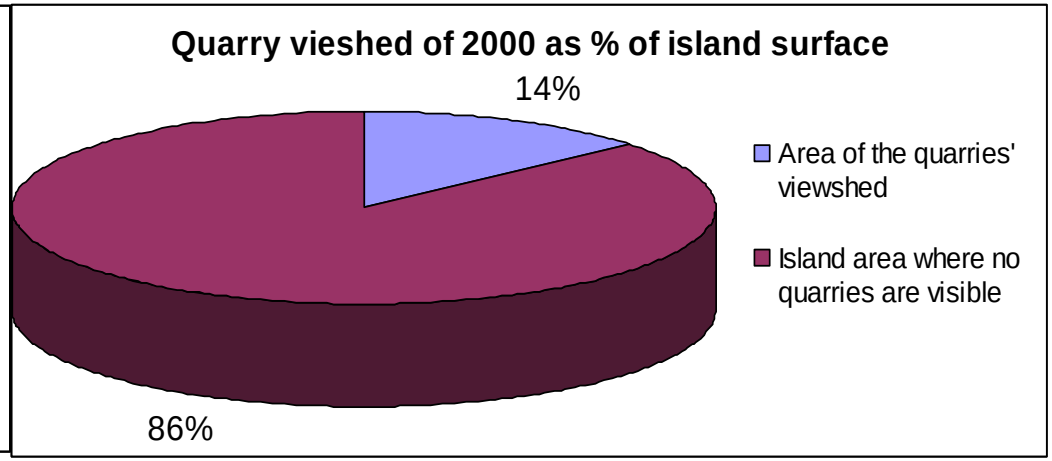
Visual impact

	1984	2000
Viewshed area of marble quarries (ha)	**4699.53**	**5179.86**
Viewshed area as % of island surface	**12.29%**	**13.54%**

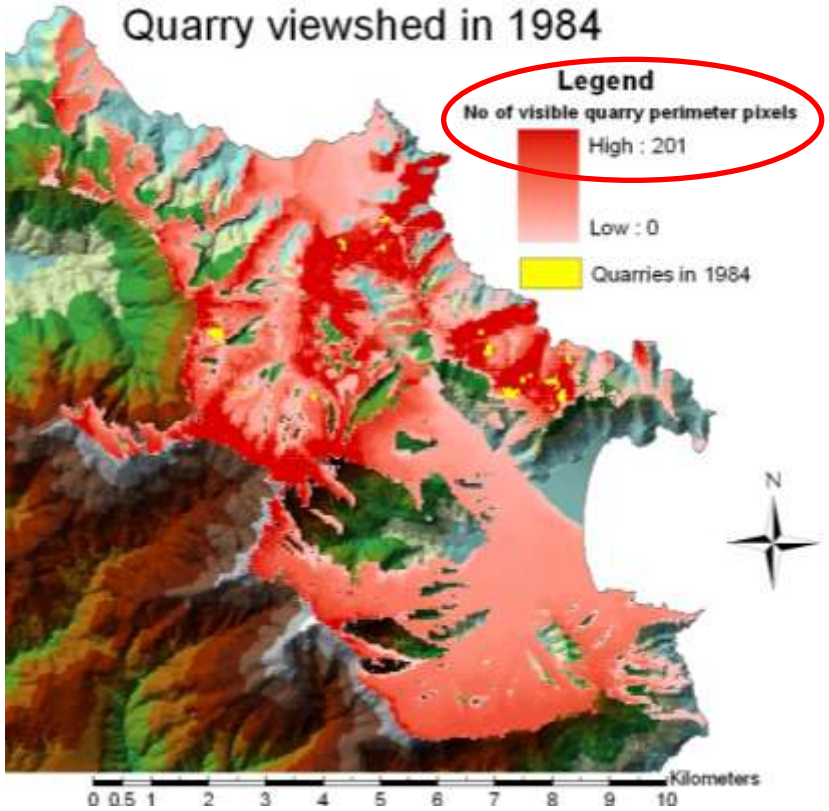
The expansion of the quarries' visibility basins is not dramatic because new quarries were created in the neighborhood of existing quarries.

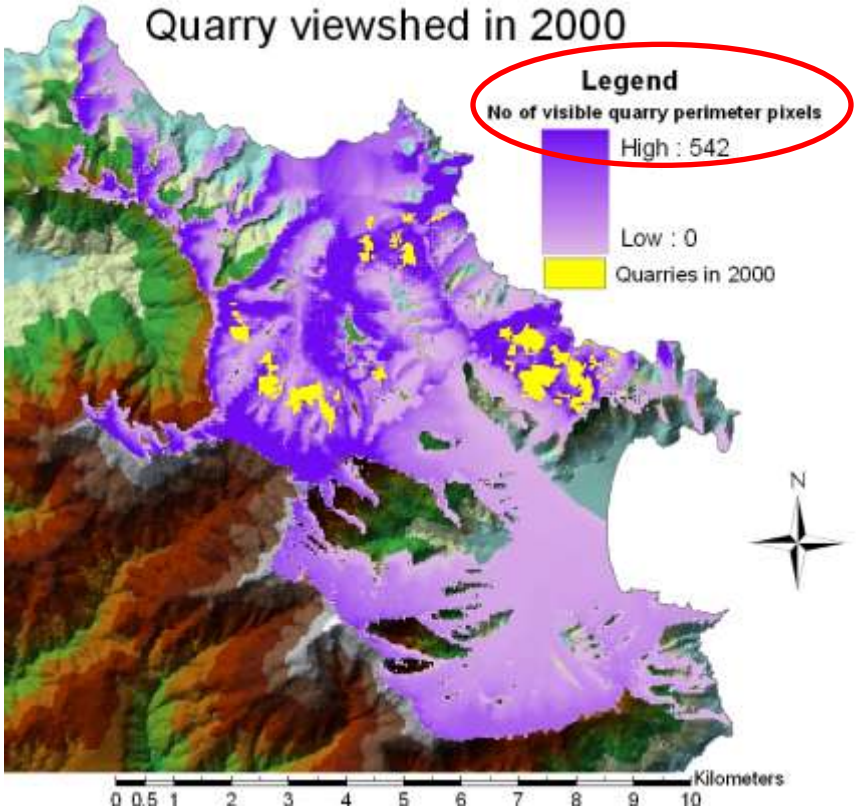
In 2000 quarries took up 0.47% of the island but affected visually 14% of the island





Visual impact





While the viewshed has not expanded considerably, the visual impact has increased dramatically, because from the same locations of the island larger areas of quarries became visible.

Visual impact

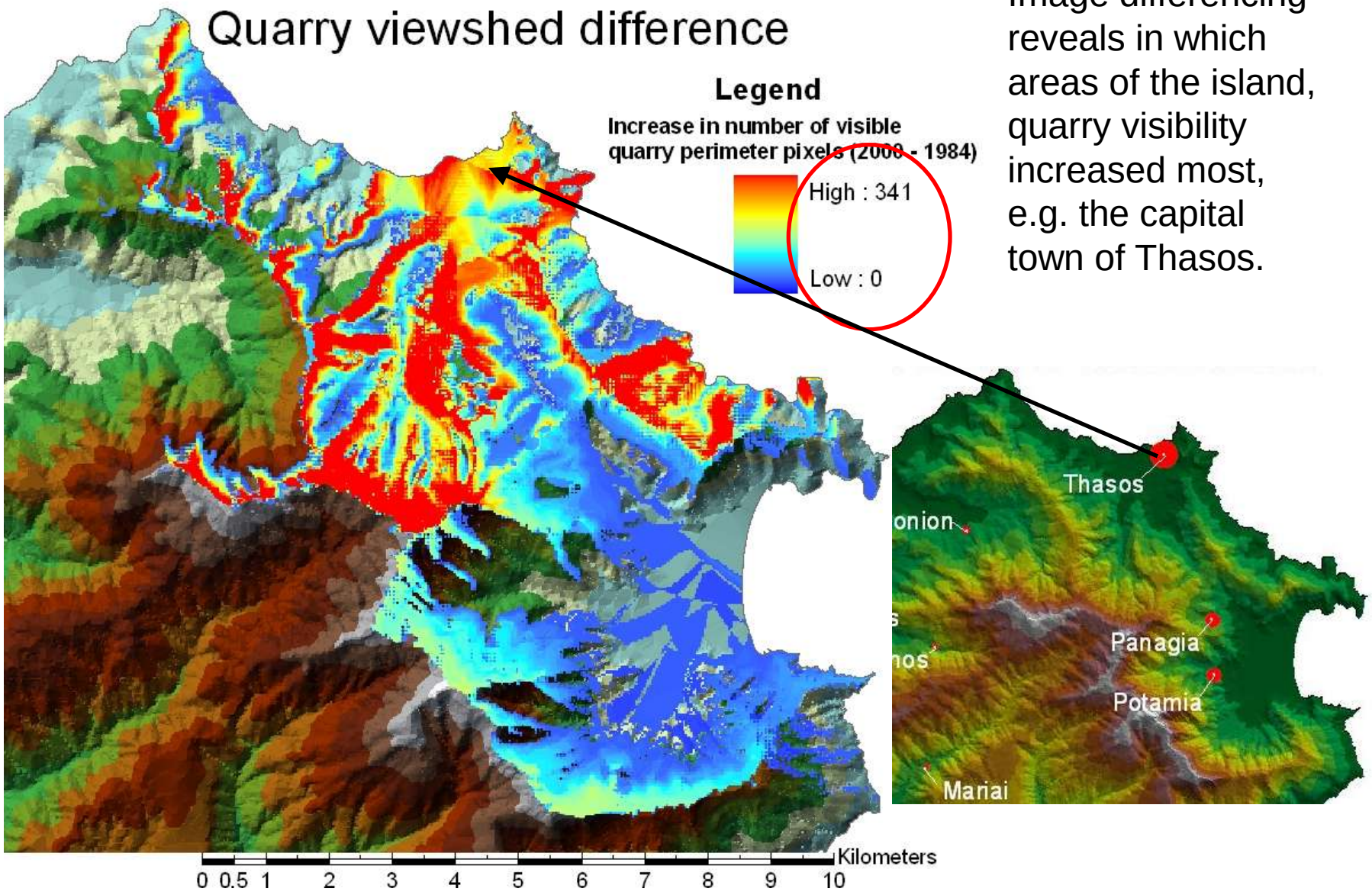
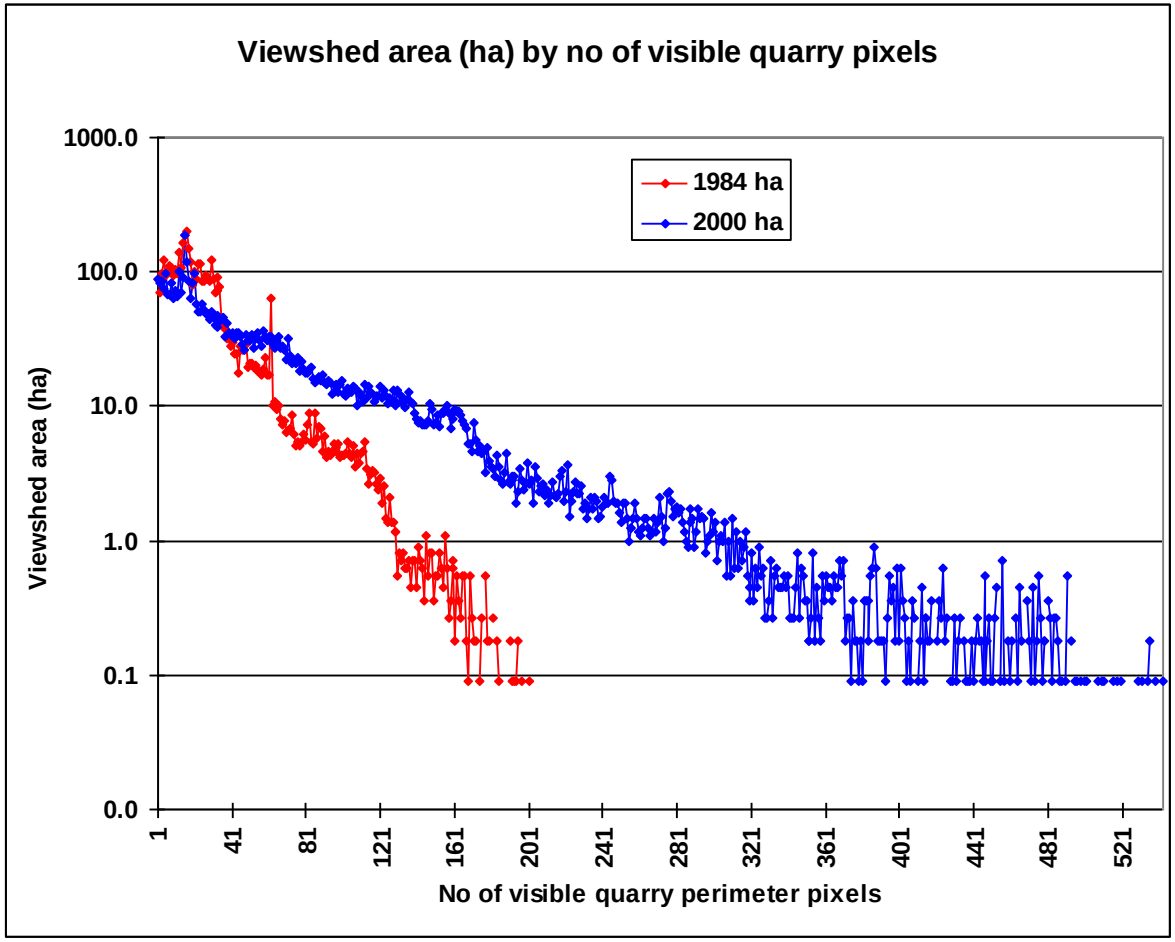


Image differencing reveals in which areas of the island, quarry visibility increased most, e.g. the capital town of Thasos.

Visual impact

It is noticeable that in 2000 the **visibility load** of quarries increased considerably.

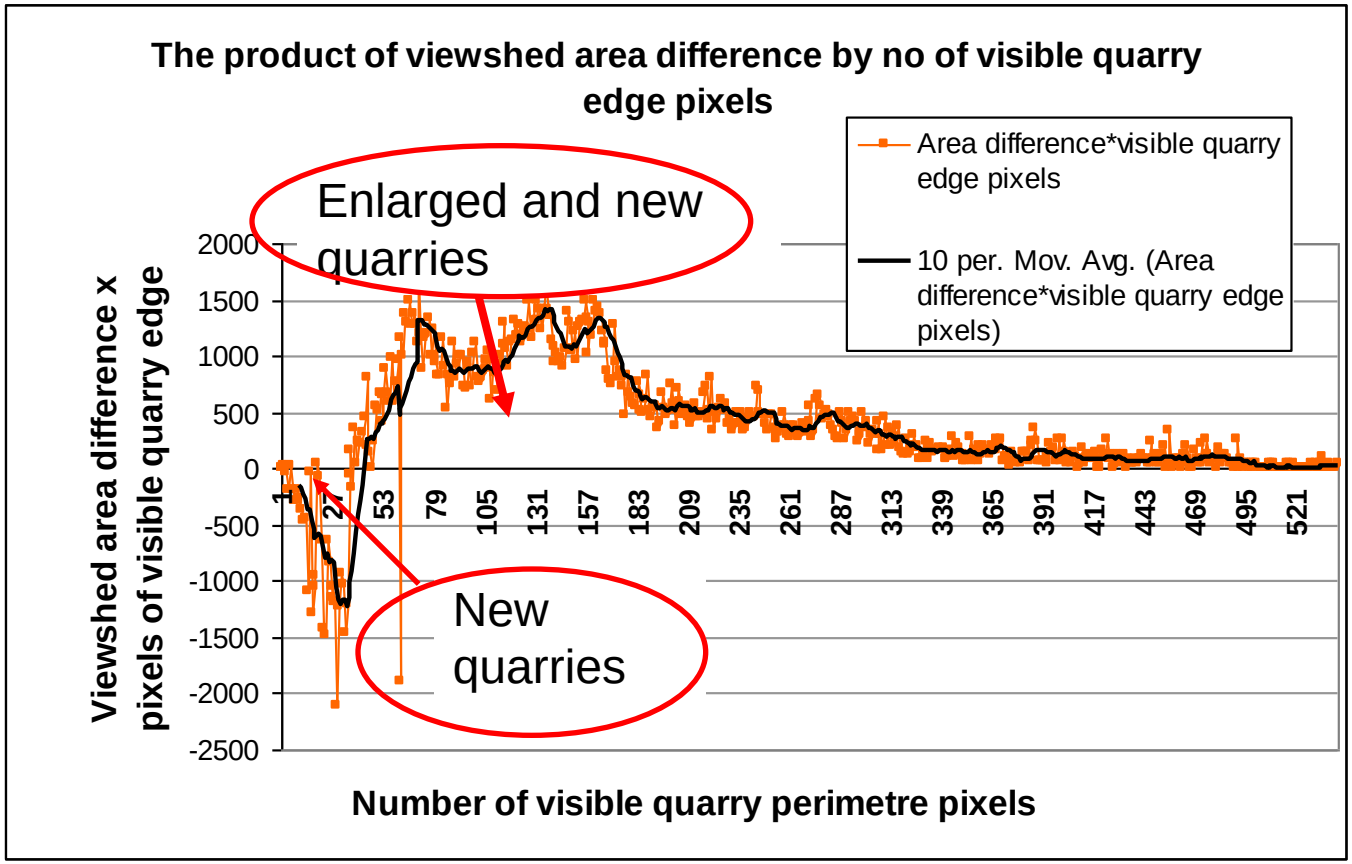


How can cumulative visibility load be quantified?

This is done by summing the product of (visibility level) x (affected viewshed area) over the entire viewshed.
These are the axes of the diagram on the left.

Visual impact

The visibility load of marble quarries on the landscape increased **252%**.



Conclusions

Marble extraction has negative environmental impacts:

- Destruction of vegetation cover.
- Visual impact and deterioration of landscape scenic quality.

Landscape monitoring by remote sensing and GIS can be successfully applied to assess the impact and dynamics of quarrying activity at a landscape scale.

Second thoughts

Marble extraction is an **economically important activity**.

BUT

- Is it environmentally sustainable currently?
- How does the landscape of Thasos look today (+6 years), and how will it transform in the future if the identified 16-year trends of quarry expansion are projected into the future?
- Is this compatible with tourism?
- Is quarry exploitation fulfilling relevant legislation requirements?
  (Law 1428/1984 and 2115/1993 → mining activities
  Law 998/1979 → forest protection
  Law 1650/1986 → Env. Imp. Assessment)

Suggestions for go-ahead of planning permissions

Planning approval of quarry activity **cannot be acceptable** if it leads to **deterioration of**:

- the aesthetic appeal of the landscape
- the scenic quality of areas where tourism often is a major constituent of income
- NO GO-AHEAD if restoration and mitigation requirements of relevant legislation are not met or if a detailed restoration schedule is not submitted on application.
- Re-examine and RECALL permission of quarries where restoration requirements are not carried out or when these are not efficient until these are met.
  Enforce relevant penalties for companies that fail to abide to planning requirements and do not allow further activities until the company fulfils restoration requirements on previously exploited quarries.

Suggestions for minimizing the quarrying impact

What can be done?

- Landscape planning and zonation:
  Carefully consider at pre-planning stage the visual viewshed of new quarries as conditioned by topographic relief. Designate **mining areas** where the visual impact will be minimal i.e. not affecting urban centres or touristically important areas.

- **Mitigation** requirements:
  Preserve topsoil from new quarry areas and create an equal area of the vegetation community that is going to be destroyed at another environmentally similar and degraded area.

- **Restoration** requirements:
  Employ restoration techniques (topsoil addition, seeding, hydroseeding, irrigation, fencing to exclude grazing etc.) to restore vegetation cover in disused quarries. Natural revegetation is not possible.




THANK YOU