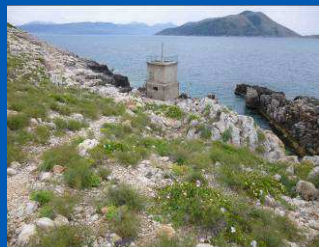




NATURALIST NOTE

March 2014



Terrestrial vascular flora and vegetation of Sazani island (southern Albania)

First assessment and main recommendations for land-management and plant biodiversity conservation

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Résumé / Abstract

RESUME :

Deux missions de terrain se sont déroulées sur l'île de Sazani (Albanie) en Septembre 2012 et Mai 2013 dans le cadre de l'Initiative PIM. A ces occasions se sont déroulées un inventaire floristique ainsi qu'une analyse de la végétation terrestre, visant à déterminer du mieux possible les listes de végétation (plantes à fleurs, fougères) présentes (taxons natifs ou exotiques) dans les différents types d'habitats, d'évaluer l'intérêt biogéographique et patrimonial de la flore, de comparer les listes floristiques avec les données de littérature antérieures, et de créer une typologie de végétation avec la réalisation d'une cartographie des formations végétales à échelle précise, qui pourra être réutilisée par les futurs gestionnaires du site.

Mots-clés :

Sazani, Albanie, flore, végétation, cartographie des habitats, diagnostic écologique

ABSTRACT :

Two field missions have been organized on Sazani island (Albania) in September 2012 and May 2013 in the framework of the PIM Initiative. At these occasions, a vascular flora survey and a terrestrial vegetation analysis were carried out in order to make the most complete list possible of vegetation (flowering plants and ferns) present (native and exotic taxa of the island) in the various habitats, to assess the biogeographical and heritage benefits of this flora, to compare the floristic data obtained with that mentioned in the consulted literature, and to create a first typology of the vegetation accompanied by a map of the vegetal formations on a scale precise enough to be used by the people working to conserve this area.

Key-words :

Sazani, Albania, flora, vegetation, habitat mapping, ecological diagnosis

General data on missions

Location : Sazani island - Vlorë (Albania)

Dates : September 03rd to 07th 2012

List of participants :

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	Vincent RIVIERE		Ferdinand BEGO
	Ivan BUDINSKI		Ludovic CHARRIER
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Lieu : Sazani island - Vlorë (Albania)

Dates : May 27th to Juin 1st 2013

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PIM Initiative for Mediterranean Small Islands

Since 2006, the Conservatoire du Littoral (French coastal protection agency) have coordinated an international program dedicated to the promotion and assistance to the management of micro-insular territories, called the PIM Initiative, co-funded by the French GEF (FFEM), the French Water Agency and the City of Marseille. The PIM initiative aims to exchange and share knowledge and know-how necessary for the emergence of good management practices of these exceptional areas.

At the occasion of field missions and trainings, wardens, scientists, technicians, naturalists, managers, NGOs or representatives of local authorities work together to promote the conservation of Mediterranean small islands, and the implementation of concrete management actions, with a positive impact on ecosystems, biodiversity, natural resources and uses.

Partnership This mission was organized in the framework of a cooperation between the Conservatoire du Littoral, the UNDP Program in charge of Albanese Marine Protected Areas, the Universities of Tirana and Vlora and the APAWA (Association for the Protection of Aquatic Wildlife of Albania), with the support of the French Embassy in Albania.

The main objective of this mission is to realize a management scheme of the island, based on the inventories done during the mission of September 2012 on the basis on the new expertise and data collected during the mission.

The inventories will improve naturalist knowledge on the site in order to define management recommendations (integrated land-sea) on the area (potentially, in coordination with the UNDP project dedicated to drafting the management plan of the MPA-Karaburuni Sazani - newly created in 2010).

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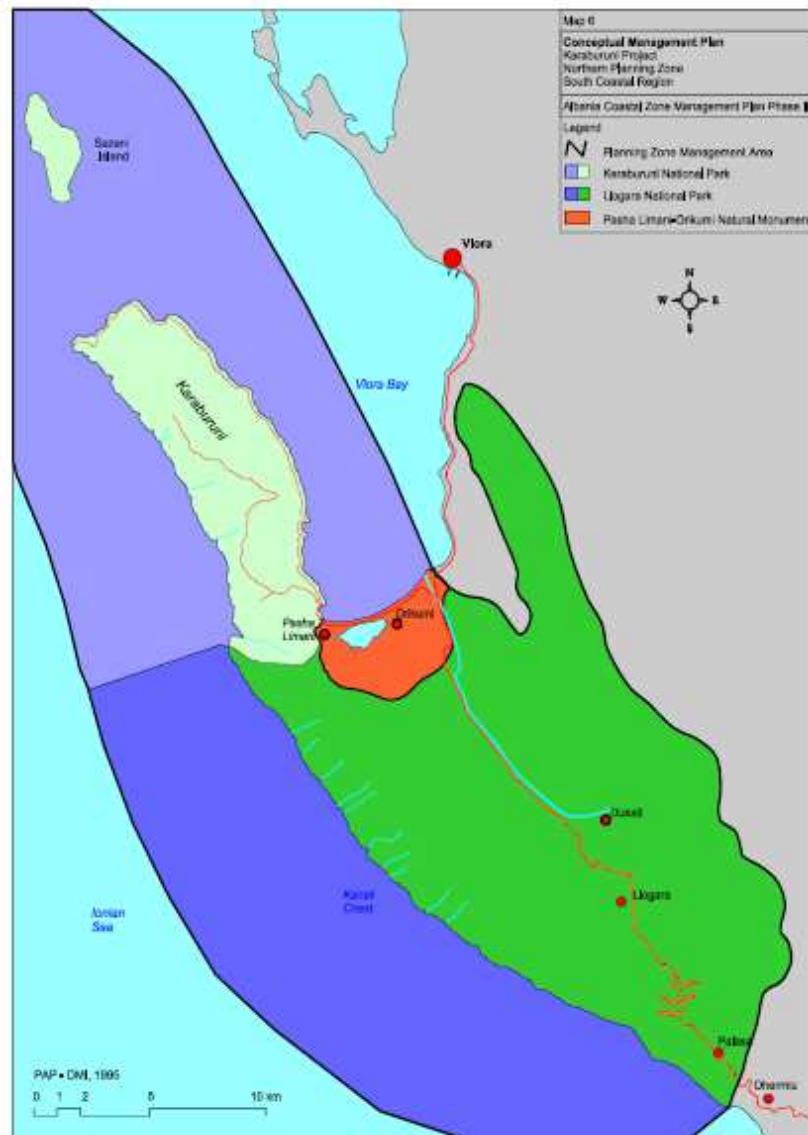
Included in the Karaburun-Sazani's AMP perimeter, Sazani Island is the biggest Albanian (570 ha, 4,8 km long and 2km wide), with a maximum altitude of 337 meters.

Located in the administrative area of the city of Vlorë, the island is situated 6,5 nautical miles west from the Port of Vlorë.

© C. Damery, 2011

Karaburun peninsula represents the western part of the Vlorë bay and is crossed by the formal border line between the Adriatic and Ionian seas. Including Sazani Island, the whole area has been identified as a priority conservation area from different national and international study sources.

However, Sazani Island is not included in the Llogara-Karaburun National Park perimeter. The establishing of the MPA of Karaburun-Sazani in 2010 (first Albanian MPA) is the first step to allow sustainable exploitation of marine area resources, while preserving its biodiversity and landscape.



Marine and terrestrial area proposed in the Management plan for coastal areas
(source : MedWetCoast, 2004)



2. Uses and history of the site

In view of its position between the Adriatic and the Ionian Sea, the island has always been a strategic military defence point.

The history of the occupation of the island is very complex, notably between the Second World War and nowadays, and the presence of military buildings, bunkers and a network of galleries are a testimony of the former important military uses of the area.

In the 15th century it was a Turkish possession, then Italian in the 18th century and then the island was handed over to Greece in 1864 and subsequently abandoned in 1914. The installation of an Italian military base was ratified in 1915 in the Treaty of London. The Italian authorities built a lighthouse and naval fortifications before settling the families of fishermen.

The island was under German occupation from 1943 to 1944 before it was taken over by Albania. The island has also certainly hosted a Russian military base.

The access to the island is controlled and ruled by the Albanian army. An Italian-Albanian military unit was set up in 1997, aiming to control the illegal traffic at sea.



Photo: C. Damery, 2011

In the 1970s, the island was thought to have been inhabited by over 300 families, mainly employed by the army and marine fleet. Buildings allowing the welcoming of a permanent population have been realized, in parallel with the development of the military base: houses, schools, hospital, library, cinema, party hall, football field. In the middle of 1980s these families were removed from Sazani and currently the island is not inhabited. The remains of numerous buildings are still to be seen today.



Photo: C. Damery, 2011

The island's inaccessibility and the lack of inhabitants made it possible to conserve the natural habitats. Currently, access to the island is possible by authorization from the Ministry of Defence and the Border Police. An additional permit is necessary from the Ministry of Environment in case of research and environmental activities. There is no regular transport to the island, but access by boat can be provided by dealing with local fishermen, when the necessary authorizations and permits from the authorities have been provided preliminary.

Actually, only a small population of military (Italian and Albanian) is living in the island.

The vascular flora survey and the terrestrial vegetation analysis of Sazani Island were carried out over two operations (September 2012 and May 2013) by the PIM Initiative, their objectives were:

- (i) to make the most complete list possible of vegetation (flowering plants and ferns) present (native and exotic taxa of the island) in the various habitats;
- (ii) to assess the biogeographical and heritage benefits of this flora;
- (iii) to compare the floristic data obtained with that mentioned in the consulted literature (Table 1);
- (iv) to create a first typology of the vegetation accompanied by a map of the vegetal formations on a scale precise enough to be used by the people working to conserve this area.

The two PIM operations represented a significant surveying effort, assessed at 21 days / person. They were carried out in order to explore all the different habitats and geographical sectors of the island, throughout mostly on foot prospecting, and completed by a few coastal landings on the south and western coastal areas of the island, inaccessible by land. The big maritime cliffs on the eastern coast were surveyed visually with binoculars from a boat.

Botanical inventories	Periods	Durations	Number of plant taxa (species and subspecies)	References
A. Baldacci & Bertrand	29-30.VI.1889	2 days	62	Baldacci (1893)
L. Del Guerra	15.V.1926	1 day	148	Fiori (1927)
P. Hoda & M. Mersinllari	21-25.V.1992 to 04-09.VI.1995	> 10 days during "3 years"	162	Hoda & Mersinllari (2000)
F. Médail, L. Charrier & L. Kashta	03-06.IX.2012	4 days	194	Mission PIM 2012
F. Médail, M. Charrier & L. Kashta	28-30.V.2013	3 days	272	Mission PIM 2013

Table 1. Synthesis of the different floristic inventories performed on the Sazani island, with the results of the number of plant taxa censused.

The surveys took into account the taxa at the species or sub-species level. These taxa were determined with the usual flora, particularly *Flora Europaea* and *Flora d'Italia*, but also in certain cases with *Flore d'Albanie* (Paparisto *et al.*, 1998; Qosja *et al.*, 1992, 1996, 2000; Vangjeli *et al.*, 2000), *Flora Hellenica*, *Flora of Turkey and the East Aegean islands*.

The plant typology was based, as much as possible, on the phytosociological method in order to facilitate the connections later between the identified habitats and the EUR27 typology used by the Habitat-Fauna-Flora Directive of 1992. The terminology used is the one adopted by the synthesis of Dring *et al.*, (2002) "*Plant communities of Albania, a preliminary overview*", completed by the work of Brullo *et al.* (2010), with several syntaxonomy corrections or precisions thanks to the prodrome of Bardat *et al.* (2004).

The identification of these various types of plants helped to create, in parallel, a vegetation map of Sazani Island, on a 1/1 500 scale, during the September 2012 PIM operation.

Well distinguished phyto-ecological units on a physiognomic and floristic composition level were identified in situ, and the individualized entities were reported on a paper base map (A1 format). The base map used for this operation came from *Digital Globe* space images which uses in particular satellites with a 60cm ground resolution. These maps are available through ESRI (GIS editor) WebService and are free to use: http://goto.arcgisonline.com/maps/World_Imagery. The main benefit is the integration in GIS with the possibility of extraction in image format (such as jpeg for example).

The phyto-ecological units were then digitized on ArcMap® 10.0 on a 1/1500 scale, with the *Digital Globe* base maps and refined by reproducing them on a topographic map of Sazani Island which had been previously digitized and geo-referenced in a WGS 84 format.

The location of the noteworthy plant species was also recorded on the vegetation map by GPS surveying done on-site.

RESULTS OF THE FLORISTIC INVENTORIES

3.1. Global pattern of plant richness

Several floristic surveys were devoted to the terrestrial vascular flora of the Sazani island (Table 1), but most of these inventories are ancient and partial. Indeed, before the PIM missions of 2012 and 2013, the flora was really imperfectly known.

The two first floristic surveys performed by Baldacci (1893) and Fiori (1927) have permit to identify 195 plant taxa (species and sub-species), but the number of common taxa between these two census was surprisingly very low (15 taxa). This number demonstrates that the floristic knowledge have to be seriously improved!

Despite the apparent intensive relevés performed more recently by Hoda & Mersinllari (2000), the number of species is again reduced ($n = 161$ taxa; 72 taxa in common with the old surveys of Baldacci and Fiori) compared to the island's size, and we have also to exclude several highly doubtful mentions [*Aegonychon purpureocaeruleum* (L.) Holub (= *Buglossoides purpureocaerulea* (L.) I. M. Johnst.); *Mercurialis perennis* L.; *Salvia verticillata* L. subsp. *verticillata*] from our global inventory of plant taxa (Annexe 1).

The total number of plant taxa reported by these three former inventories was 284 species and subspecies.

The two floristic inventories conducted during the 2012 PIM mission (September) and the 2013 PIM mission (May), have respectively permit to identify 194 and 272 taxa (164 taxa were found both during the two surveys, but 84 taxa not sampled in 2012 were recorded in 2013). The spring mission of 2013 was of course more favourable according to the plant phenology, and this is the reason why the plant richness of this survey was higher than the one of September.

The total number of native and alien taxa currently censused on Sazani island during the field missions of 2012-2013 (i.e. "current floristic richness") is equal to 321 plant species and subspecies (Table 2). If we consider only the native taxa, this current richness peaks at 300 taxa.

164 taxa are new for the island, i.e. that they were never recorded on the island before these two inventories.

Finally, the global number of plant taxa mentioned by the ancient and current surveys is 448 plant species and subspecies including native and alien taxa (i.e. "total floristic richness"), or 424 native species and subspecies.

The comparison with the total number of vascular plant species of Albania, estimated to about 3500 native taxa (Miho *et al.*, 2013), indicates that the Sazani flora represents between 8,2% (current floristic richness) to 12% (total floristic richness) of the whole plant richness of this country, but on a insular area (surface = 5.70 km²) representing only 0,0002% of Albania (surface = 28.748 km²).

PIM Missions	Total number of plant taxa	Number of native taxa	Number of alien taxa	Number of new taxa for Sazani island
September 2012	194	181	15	80
May 2013	272	260	16	84
Total	321	300	21	164

Table 2. Results of the floristic inventories conducted during the PIM missions of September 2012 and May 2013.

If we compare these floristic patterns with those obtained for some other Mediterranean islands characterized by similar physiographical characteristics (surface, altitude, distance to mainland), it appears that Sazani island exhibits a relatively poor plant species richness (Table 3).

Of course, if the current floristic survey cannot be considered as exhaustive, we are confident that our inventories are almost complete, since an important field work was performed within the different areas of the island and it was also focused in order to have a stratified sampling for each habitat type.

Islands	Main physiographical characteristics	Total number of current plant taxa	Number of current native taxa (all inventories)	Number of current alien taxa
Sazani Island	S: 570 ha ; A: 344 m; D: km	321	300 (424)	21
Port-Cros (SE France)	S: 627 ha ; A: 195 m; D: 8,54 km	523	465 (485)	58
To be completed				

Table 3. Comparative results of the floristic richness of the Sazani island, with regards to some other Mediterranean islands (F. Médail, ined.). S: surface area (ha); A: altitude (m); D: distance to the closest mainland (km).

3.2. Comparison with ancient plant inventories

Although the old data is rather rare and incomplete, it still provokes some thought on the floristic species' dynamic over the last century. The number of plants recorded by Baldacci (1893) and Fiori (1927) that were not found again during the 2012 - 2013 PIM operations adds up to 98 taxa, i.e. over 20% of the island's total flora, including three exotic or planted species (*Ailanthus altissima*, *Phytolacca americana* and *Pinus pinaster*).

The analysis of these missing species, which of course cannot be proven to have completely disappeared from the island, shows that three quarters of them (n = 64, i.e. 74% of the missing species) are open area species, particularly ruderal species, near farms, fields, paths and barren vegetation, which have not been found again. Amongst them, there are many plants which are very common in the fields and farms of the Vlora region (*Cardaria draba*, *Glebionis coronaria*, *Glebionis segetum*, *Papaver rhoeas*, *Raphanus raphanistrum*, *Sisylx atropurpurea*, *Tragopogon porrifolius*...). The probable disappearance of several annual Fabaceae should also be noted within the *Hedysarum*, *Lathyrus*, *Lotus*, *Lupinus*, *Medicago* and *Trifolium* genus, and of four species of *Bupleurum* recorded by Baldacci (1893), and of three taxa of *Centaurea*. At the time of their survey in 1889, Baldacci and Bertrand noted that the island was uninhabited, but they reported fields and small vineyards which had been abandoned for about twenty years and a few ruined homes (Baldacci, 1893); a good part of the plants growing in the fields there lasted until the 1930s (Fiori, 1927).

Local extinctions also concern the natural grassland taxa in warm and dry areas (*Convolvulus cantabrica*, *Convolvulus cneorum*, *Helichrysum stoechas* subsp. *barrelieri*, *Ophrys bertolonii* aggr.). Certain species tied to humid areas were not reported in 2012 - 2013 (*Carex flacca*, *Juncus maritimus*, *Phalaris aquatica*, *Scirpoides holoschoenus*) as well as two taxa from coastal habitats (*Limonium virgatum*, *Medicago marina*).

PHYTOGEOGRAPHICAL INTERESTS AND PLANTS WITH PATRIMONIAL VALUE

4.1. Phytobiogeographical benefits and insular specificities

Sazani Island is located in a complex sector on a biogeographical level, in between the eastern and western parts of the Mediterranean basin. This explains the presence of floristic elements near the area limit that came from longitudinal species migration, particularly from Greece towards south eastern Italy (Figure 1), during favorable periods (paleo-geographical or paleo-climatic) during the Tertiary or Pleistocene, as well as the oriental coast on the Adriatic which played an important sheltering role during the quaternary ice ages (Médail & Diadema, 2009), which explains the persistence up to now of some very ancient plant lineage (Gesneriaceae: *Ramonda*; Amaryllidaceae: *Acis ionica* near Vlora).

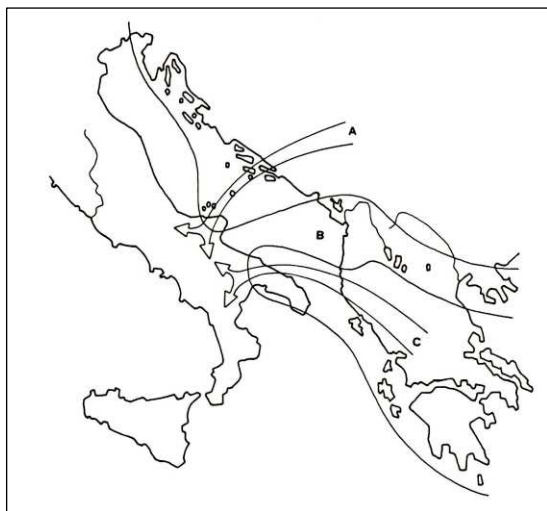


Figure 1. Diagram of the main floristic currents identified in the Adriatic and west-Aegean regions, which occurred during the tertiary; A: Gargan Bridge; B: trans-Aegean corridor, from the Thessaloniki Gulf (Greece) to Apulia (Italy); C: Otranto straight bridge. Map: Lorenz & Gembardt (1987), according to Gridelli (1950) and Nelson (1962).

According to the phyto-geographical analysis by Rivas-Martínez *et al.* (2004) in the framework of the *Biogeographic map of Europe*, Sazani Island is positioned at the heart of the Holarctic empire, Mediterranean region, western Mediterranean sub-region, Adriatic province, Epiro-Dalmatian sub-province (reference as 21b on the map in figure 2).

The later presents strong biogeographical ties with the Apulian sub-province (southern coast of western Italy): “21a”) and the Peloponnese sub-province in Greece (“21c”), which can be explained by the tertiary floristic currents previously mentioned.



Figure 2. Phyto-geographical position of Sazan Island, in the heart of the Adriatic province, Epiro-Dalmatian sub-province (“21b”); according to Rivas-Martinez et al. (2004).

The biogeographical location of Sazan explains the presence of several plants in the area limit, particularly near the rupicola communities (rocks and cliffs), which shelter mainly oriental elements in the western limit (*Aurinia saxatilis* subsp. *orientalis*, *Brassica cretica* subsp. *aegaea*, *Inula* cf. *aschersoniana*, *Campanula ramosissima*, *Crepis discoridis*, *Echinops sphaerocephalus* subsp. *albidus*). Amongst the other oriental taxa of non rupicola genus in the western distribution limits was noted: *Anthemis auriculata*, *Delphinium hellenicum*, *Serapias* aggr. *orientalis*. There are also a few oriental species reported on Sazan which have reached the Adriatic coast of Apulia in Italy (*Cerintho retorta*, *Ephedra foeminea*).

Several central-Mediterranean species with a rather limited distribution surface were also reported on the island (*Anchusella cretica*, *Bubon macedonicum*, *Campanula versicolor*, *Hypericum spruneri*), including the sub-endemic *Centaurea pawlowski* and *Scutellaria rupestris* subsp. *adenotricha* and *Verbascum guicciardii*. Several other sub-endemic species reported in the old surveys (*Bupleurum flavicans*, *Centaurea spruneri* subsp. *guicciardii*, *Haplophyllum coronatum*) were not found during our 2012 - 2013 surveys, and have most probably disappeared from the island.

However, endemism in the stricter sense seems does not seem to be very present, as only *Limonium anfractum* is listed in this category.

This first assessment can still be perfected as the flora of southern Albania is still not well known and deeper systematic analysis would allow to better estimate the biogeographical links with the close regions and also the originality of the evolution of certain taxa on the island, particularly the coastal and rupicola ones.

Other than the presence of rare species which are very interesting on a biogeographical level, islands are often characterized by different compositions or abundance of species, compared to similar continental situations, and Sazan Island is no exception to this.

Even though the “density inflation” phenomenon remains difficult to assess on Sazan, as precise continental references were not carried out on the nearby coast due to a lack of time, the large frequency and the abundance of certain species, particularly labiatae, should be mentioned: *Teucrium capitatum* aggr. With habits and ecological dynamics similar to those of the *Teucrium polium* subsp. *purpurascens* of the Frioul Islands (Provence, France), or *Scutellaria rupestris* subsp. *adenotricha*, very abundant in the rocky grasslands at the summits of the island.

On the contrary, there is a striking number of plants absent on Sazan which are common in the various continental ecosystems in the Vlora region and the Karaburun Peninsula. Thus, the presence of Valona oak populations (*Quercus ithaburensis* subsp. *macrolepis*) should be noted on the eastern coast of Karaburun, not far from Sazan, and woody plants such as Judas trees (*Cercis siliquastrum*), Hackberries (*Celtis australis*), Strawberry trees (*Arbutus unedo*), and wild Almond trees (*Amygdalus* sp.). Common plants in Karaburun’s coastal sclerophyll matorral, such as the tree heath (*Erica arborea*, *Erica multiflora*), the smoke tree (*Cotinus coggygria*), or on the rocky coast (*Euphorbia spinosa*) are also absent on Sazan.

These floristic composition particularities demonstrate the distinct insular character of Sazan’s flora, despite not being very far from the continental coastlines (the Mesokanali Strait which separates the island from the Karaburun Peninsula is only 4.9km wide), and the islands continental origins.

4.2. Sazan island 's significant species

The floristic surveys on Sazan helped to highlight the presence of twenty one plant species new to Albania (Table 4), not including the three species (*Brassica cretica* subsp. *aegaea*, *Lotus cytisoides* and *Orobancha lavandulacea*) just recently reported in the country (Barina et al., 2011, Rakaj et al. (2013)), to which several other interesting taxa can be added on a biogeographical level.

The results are very interesting in regards to the island's very small surface size; it shows that southern Albanian flora must still have some interesting discoveries to be made and that this island could have been a shelter for taxa often at the limit of the distribution area.

New taxa	Family	Biogeographical status in Albania	First mention in Albania	Status on Sazani island
<i>Allium commutatum</i> Guss.	Amaryllidaceae	Native species, micro-insular specialist	Mission PIM 2012	Quite common on rocky coastal habitats of the south
<i>Anthemis auriculata</i> Boiss.	Asteraceae	Native species, Eastern limit of distribution	Mission PIM 2013	Very rare
<i>Arabis planisiliqua</i> (Pers.) Rchb.			Mission PIM 2012	
<i>Asparagus albus</i> L.			Mission PIM 2013	
<i>Brassica cretica</i> Lam. subsp. <i>aegaea</i> (Heldr. & Halácsy) Snogerup <i>et al.</i>	Brassicaceae	Native species, north-eastern limit of distribution	Barina <i>et al.</i> (2011)	Quite common on coastal cliffs
<i>Carduus tenuiflorus</i> Curtis	Asteraceae	Native species?, Western limit of distribution	Mission PIM 2013	Common on ruderal habitats around the harbour and the old village
<i>Centaurea pawlowskii</i> Phitos & Damboldt	Asteraceae	Native species, Eastern limit of distribution	Mission PIM 2012	Quite common on coastal and inland cliffs
<i>Delphinium hellenicum</i> Pawl.	Ranunculaceae	Native species, north-eastern limit of distribution	Missions PIM 2012 & 2013	Very rare on ruderal grasslands above the harbour
<i>Euphorbia maculata</i> L.	Euphorbiaceae	Alien species	Mission PIM 2012	Common on the gravel soil near the harbour
<i>Inula cf. aschersoniana</i> Janka	Asteraceae	Native species, Eastern limit of distribution	Mission PIM 2012	Rare on coastal and inland cliffs
<i>Jacobaea maritima</i> (L.) Pelser & Meijden subsp. <i>maritima</i>	Asteraceae	Native species, Eastern limit of distribution	Mission PIM 2012	Very rare on a coastal cliff of the eastern coast
<i>Limonium arctuatum</i> P. Artelari			Mission PIM 2013	
<i>Lotus cytisoides</i> L.			Barina <i>et al.</i> (2011)	
<i>Ononis mitissima</i> L.	Fabaceae	Native species	Mission PIM 2013	On a grassland in the southern part
<i>Ornithogalum arabicum</i> L.			Mission PIM 2013	
<i>Orobanche lavandulacea</i> Rchb.	Orobanchaceae	Native species	Barina & Pifko 2008b; Malo & Shuka 2008a	Very rare on a coastal cliff of the eastern coast, on <i>Bituminaria bituminosa</i>
<i>Polypogon subspathaceus</i> Req.	Poaceae	Native species	Mission PIM 2012	On some annual grasslands
<i>Scolymus cf. maculatus</i> L.			Mission PIM 2013	
<i>Serapias orientalis</i> (Greuter) H. Baumann & Künkele	Orchidaceae	Native species	Mission PIM 2013	On a rocky grassland in the north-eastern part
<i>Urtica membranacea</i> Poir.			Mission PIM 2013	
<i>Veronica persica</i> Poir.			Mission PIM 2013	

Table 4. List of the new vascular plant species for the flora of Albania, discovered on the Sazani island during the two PIM missions of 2012 and 2013.

Rare or interesting species on a biogeographical level

Allium commutatum Guss. FM

A species new to Albania, island garlic is a taxon found almost exclusively on small Mediterranean islands, in both maritime habitats in the rock and cliff crevices and on earthy ruderal flats; it is still not very common in the western Balkans and was only recently reported on the Croatian coast for example (Starmühler, 2005).

Allium subhirsutum FM

Anthemis auriculata Boiss. MC

Asyneuma limonifolium MC

Aurinia saxatilis subsp. *orientalis* MC

Brassica cretica Lam. subsp. *aegaea* (Heldr. & Halácsy) Snogerup *et al.* FM

Aegean cabbage is a chasmophyte found in the calcareous cliffs and rocks of the eastern Mediterranean, often located on limestone islets, and this plant is present in Greece (common in south and central Aegean area, scattered further west where it reaches Corfu) and SW Anatolia (Snogerup & Snogerup, 2002: 280-282). It was recently recorded in Albania on a few calcareous coastal cliffs (south of Vlora and the Palermo Peninsula) where it was mistakenly taken for *avec Brassica oleracea* (Barina *et al.*, 2011). The populations of Sazani are located on the NW extreme limit of its distribution area.

Campanula ramosissima (det greuter) (*Campanula sparsa* Friv. aggr.) MC

Campanula versicolor FM

Capparis orientalis FM

Carduus tenuiflorus MC

Centaurea pawlowskii Phitos & Damboldt FM

Crepis dioscoridis MC

Delphinium hellenicum Pawl. MC

Dryopteris pallida MC

Echinops sphaerocephalus subsp. *albidus* FM

Echium calycinum ? MC

Ephedra foeminea ? FM

Erica manipuliflora ? FM

Euphorbia peplis ? MC

Galium intricatum MC

Helictotrichon convolutum MC

Hypericum spruneri MC

Very close to *H. perfoliatum* and often mistaken for it

Inula cf. aschersoniana Janka FM

Jacobaea maritima (L.) Pelser & Meijden FM

Limonium anfractum DP

Limonium arctuatum DP

Lotus cytisoides L. subsp. *cytisoides* FM

This halophile taxa, common on the peri-Mediterranean coasts, was strangely only recorded in Albania 1986 on some coastal rocks of the district of Sarandë (Ksamil) and likewise omitted from recent Albanian basic floras (Demiri, Fl. Eksk. Shqipërisë, 1983; Qosja & al., Fl. Shqipërisë 2. 1992) according to Kit Tan & Mullaj (2000). It is quite common

on the cliffs and coastal rocks on the southern coasts of Sazani Island, where it also grows on more earthy and ruderal flats, with *Allium commutatum*.

Ononis mitissima L. MC

Orobanche lavandulacea Rchb. FM

Poa media MC

Polypogon subspathaceus Req. (cf. Mullaj et al. 2010 pour *P. maritimus*) FM

Putoria calabrica ? FM

Scolymus cf. *maculatus* MC

Scutellaria rupestris subsp. *adenotricha* FM

Selaginella denticulata MC

Serapias orientalis (Greuter) H. Baumann & Künkele MC

Verbascum guicciardii MC

TERRESTRIAL VEGETATION : INVENTORY, CARTOGRAPHY AND ESTIMATION OF ECOSYSTEMS DYNAMICS

5.1. Terrestrial plant communities

The on-site detailed analysis and mapping of Sazani's vegetation highlighted 54 different plant communities (i.e. either a plant association on a sigmatist phytosociology level, either a plant formation or a particular vegetation structure) which can be grouped into 8 major types of vegetation (Annex 1).

These results highlight all the habitat and plant formation diversity present on the island, and contrasts with the data by Hoda & Mersinllari (2000) who only individualized around ten plant communities, but stated: "*Sono state studiate le comunità vegetali più evidenti*"...

Of course, more precise typological work should be carried out, particularly on a phytosociological characterization level, with the associated phytosociological data recorded for each one. Indeed, it was not often possible to associate the surveyed plant formations with a precise syntaxon on a "plant association" level. However, this approach is way beyond the framework of this current research, as it should incorporate all the plants of southern Albania and their relations with plants identified in north-western Greece and southern Italy.

This analysis however provides a rather researched typology, which highlights the importance of rupicola plants (rock and cliff formations) in maritime locations or a bit further inland and, to a lesser degree, some rocky not very ruderal grasslands. These plants have a strong local diversity in types of communities often with important biogeographic benefits.

- Vegetation of sea-cliffs and maritime rocks

The maritime rocks and cliffs shelter halophile or haloresistant plants from many various significant taxa on a biogeographical level. The most halophile communities on coastal rocks are well represented on the southern part and are composed in particular of *Limonium anfractum* (endemic) and *Lotus cytisoides* (very rare in Albania), whereas the rocky flats, rather ruderalized because of their situation as a resting place for marine birds, shelter communities dominated by island garlic (*Allium commutatum*), a micro-insular specialist new to Albania, and *Lotus cytisoides*, *Malcolmia maritima*, *Euphorbia linifolia*, and *Beta vulgaris* subsp. *maritima*. The important frequency of the oriental caper bush (*Capparis orientalis*) should also be noted in the crevices of maritime rocks, it even grows a few meters from the sea, where it is subjected to sea-spray.

The calcareous maritime cliffs that are well exposed to the sun, particularly those on the south-west, and to a lesser degree those of the north-east, shelter communities of Aegean cabbage (*Brassica cretica* subsp. *aegaea*), Pawlowski Centaury (*Centaurea pawlowskii*), bellflowers (*Campanula versicolor*), where several other interesting perennial species are associated (*Aurinia saxatilis* subsp. *orientalis*, *Ephedra foeminea*, *Echinops sphaerocephalus* subsp. *albidus*, *Inula* cf. *aschersoniana*); this undescribed community is probably synendemic in a phytosociological sense,

due to its particular species composition not identified on the nearby continent (Karaburuni Peninsula and the rocky coasts of southern Vlora).

- Chasmophytic vegetation of inland rocks and cliffs

In locations further inland, small cliffs, rocks and stone walls can also shelter - though more sporadically and on smaller surfaces - certain species such as (*Brassica cretica* subsp. *aegaea*, *Centaurea pawlowskii*, *Campanula versicolor*) whose ideal ecological location would be on maritime cliffs as previously mentioned. In addition to these, a more xero-thermophile flora can be found alongside such as *Euphorbia dendroides*, *Putoria calabrica*, *Prasium majus*, *Phagnalon rupestre*, *Piptatherum caerulescens*... In the driest rocky areas, only groups of *Phagnalon* and *Piptatherum* remain.

In the crevices of calcareous rocks where micro-pockets of terra rossa soil can accumulate which are a bit humid in spring and winter, communities characterized by *Parietaria lusitanica*, *Ruta chalepensis* and some ferns (*Asplenium ceterach*, *Asplenium onopteris*, *Cheilanthes acrostica* and *Selaginella denticula*) can be found. Finally on some calcareous cliffs and marly slopes of the central-eastern coast, formations of *Cephalaria leucantha* or *Centaurea pawlowskii* and *Echinops sphaerocephalus* subsp. *albidus* have developed and are frequently associated.

- Perennial rocky communities

In the calcareous rocks of the southern coast particularly, and on the scree frequent on the slopes around the three summits of the island, various types of plant formations can be found, from rocky grasslands to shrublands, and both can be interspersed. These formations are more or less colonized by ruderal species (*Asphodelus aestivus*, *Hypericum spp.*, *Dittrichia spp.*, *Acanthus spinosus*) which spread a lot when they are around old military installations.

The steppe grasslands and the rocky areas of the south are characterized by formations of *Hypparhenia sinaica* and *Drimys numidica*, *Ornithogalum arabicum* and *O. narbonense*, *Verbascum guicciardii*, interspersed with *Pistacia lentiscus*, *Phlomis fruticosa* and *Salvia fruticosa* and *S. officinalis*.

The low bush shrublands on the slopes and rocky flats near the summits form rather spectacular landscapes dominated by Lamiaceae (*Teucrium capitatum* aggr., *Teucrium flavum* and *Scutellaria rupestris* subsp. *adenotricha*).



a



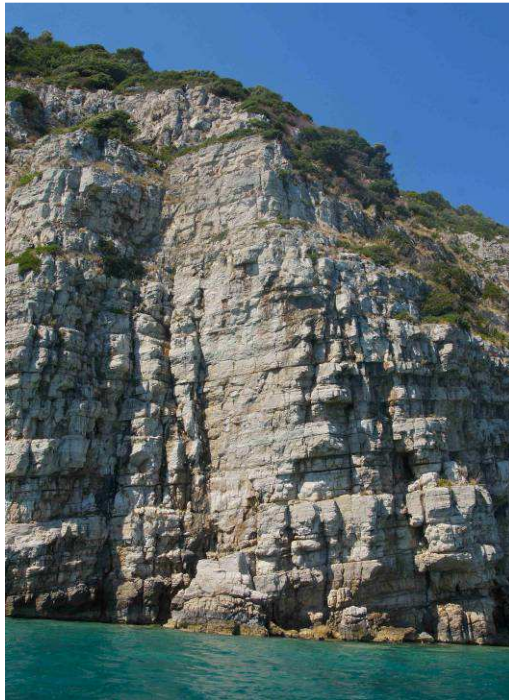
b



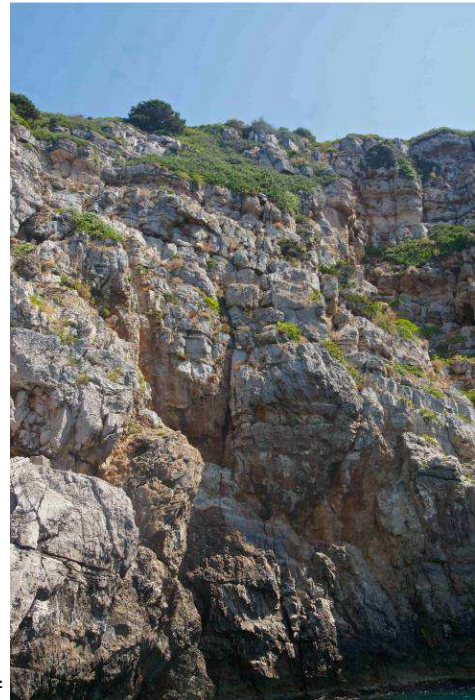
c



d



e



f

Panel 1. Sazani's maritime cliff and rock plant formations and species. a : rock with oriental caper plant (*Capparis orientalis*) and island garlic (*Allium commutatum*); b: *Capparis orientalis* flower; c: ruderal flats with budding *Allium commutatum*; d: *Capparis orientalis* and *Limonium anfractum* formations on the southern tip of the island; e & f: cliffs on the southern part of the island with *Capparis orientalis*, *Juniperus phoenicea* subsp. *turbinata*, *Ephedra foeminea*, *Brassica cretica* subsp. *aegaea*, *Centaurea pawlowskii*, *Allium commutatum*, *Crithmum maritimum* (photos F. Médail / IMBE).



a



b



c



d



e



f

Panel 2. Characteristic plants of Sazani Island's maritime calcareous cliffs and rocks. a & b: Pawlowski Centaury (*Centaurea pawlowskii*); b & c: Aegean cabbage (*Brassica cretica* subsp. *aegaea*); e & f: Bellflowers (*Campanula versicolor*) (photos F. Médail / IMBE).

5.2. Global evaluation of forest ecosystem dynamics

Because of the lack of historical and paleo-ecological data, it isn't possible to accurately estimate Sazani Island's potential vegetation, i.e. the most evolved plant formations present in an area according to local environmental conditions and without major human interference. Indeed, multiple human disruptions in the past have significantly changed the structure and the composition of most of the island's ecosystems, not including the rock and cliff's azonal habitats. However, the fact that the island has been practically completely abandoned for a few decades and the lack of large herbivore fauna vertebrae allow a rather rapid vegetation dynamic that can be qualified as "progressive series" towards the reconstitution of forest formations that would be more mature than the existing ones.

The presence of a majority of thermophile plants (ex: Tree Spurge, *Euphorbia dendroides*; wild olive tree, *Olea europaea* subsp. *europaea*; white hedge-nettle, *Prasium majus*; *Drimys numidica*; white asparagus, *Asparagus albus*...) shows that the whole island is within the thermo-Mediterranean vegetation zone (Quézel & Médail, 2003). Most of the island is therefore covered with thermophile matorral in more or less evolved successional phases, some of which are in the pre-forest stages. In the absence of major disruptions (such as fires) in the future, the global dynamic should be heading towards two main types of forests:

- Mediterranean forests, woodland and scrub with evergreen oaks (*Quercus ilex* subsp. *ilex*) in the most thermo-xerophile areas, on rocky superficial soil;
- Broadleaf and mixed forests with Hop Hornbeams (*Ostrya carpinifolia*) and South European Flowering Ashes (*Fraxinus ornus*), sometimes mixed with evergreen oaks, in more fresh and humid areas and on deeper soil. These kinds of formations, still rather limited but in current progressive colonization, can be found on one of the eastern slopes on the north-eastern coast of the island. Even the western dryer side, could go through such a dynamic, as an important colonization of *Fraxinus ornus* was found on a north-western part of the island in a matorral of *Lentiscus* (*Pistacia lentiscus*), kermes oaks (*Quercus coccifera*) and Mediterranean buckthorn (*Rhamnus alaternus*).

The absence - natural or artificial - of other woody broadleaves, particularly that of the Vallona oak (*Quercus ithaburensis* subsp. *macrolepis*), is striking, as it is widespread on the north-eastern coast of the Karaburun Peninsula, just a few kilometers away. This absence had already been reported at the end of the 19th century by Baldacci (1893): "*Non vidi un esemplare di Quercus Aegilops L. (vallonea) benchè quest'albero formi foreste sviluppate in tutte le colline vicine al mare della terraferma*". This means that a broadleaf oakwood implantation would not be foreseen in the medium term. This kind of formation could only occur naturally when the areas conditions become more mesophile, through the maturing of the current forests and pre-forests, and when forest avifauna is well established to favor the spreading of acorns by avian transportation (dyszoochorie).

Finally, the reforestation of the Turkish Pine (*Pinus brutia*) or its hybrid, and the Cyprus (*Cupressus sempervirens*) are destined to general aging, without adequate regeneration as the shrubby substrata of these artificial populations is densifying and won't guarantee a sufficient regeneration niche for these heliophile species.

5.3. The case of an area closing due to proliferating indigenous species

A few proliferating plant species, i.e. normally indigenous plants with very strong expanding and competing capabilities, are occupying large surfaces of Sazani Island; this occupation of space in barren areas or around ruined constructions is a sign of "ecological dysfunction" that can be more or less ancient.

The plants concerned are the bracken also known as eagle fern (*Pteridium aquilinum*) and a blackberry bush (*Rubus plicatus*) which can form rather large mono-specific landscapes, and also other ruderal species (favored by disruptions and soils enriched by nitrogenous or phosphorous compounds) such as the inula (*Dittrichia viscosa* and *D. graveolens*) with end of summer or autumnal phenology.

The density of some of these landscapes, particularly the inextricable blackberry thickets, leads to a closing of grassy areas which could cause prejudice to the maintaining of some of the vertebrate fauna (herpetofauna and avifauna).

It is therefore possible to consider opening these areas, through agriculture or even controlled burning.

However, we do not recommend those kinds of management methods because:

- (i) It seems preferable to let the natural dynamics of post-culture or post-disruption recolonization develop in these areas that have already been impacted enough in the past;
- (ii) Some of these areas have interesting floristic combinations on a biogeographical level: such as the areas with St John's Worts (*Hypericum spruneri*, close to *H. perforatum*) and Spiny Bear's Breeches (*Acanthus spinosus*), not to mention the diverse number of insects associated to these plants that P. Ponel (comm. pers.) qualifies as "*a fauna of very diverse herbivore insects, for example: the Lygus italicus heteroptera which is new to Albania, many butterflies and hymenoptera, and many ants from the Messor genus*";
- (iii) It would be very difficult, maybe even impossible, to efficiently limit the occupation of these landscapes without heavy and costly intervention which may not even succeed, due to the very strong recolonizing capabilities of the competitive plants implicated;
- (iv) Managing the area with pasture animals could only be done with rustic livestock species, particularly caprids, but the risks of their uncontrolled expansion on such an insular system are severe and would lead to much graver ecological consequences than that of the closing of an area, which by nature is temporary, like all phases of a

dynamic ecological system that changes over time

The only exception that could be considered to this “globally non-interventionist principle” could be the minor management of the rare temporary river banks of the island, to restore a sufficient opening of the area which is densifying due to the development of woody species and lianas (brambles and salsapareille). This applies in particular to the “Devil’s Valley” (central-western coast of the island), which is completely inaccessible. Manual cuts could be carried out under an ecologist’s supervision with the evacuation of coarse woody debris, to favor heliophile species and habitats tied to freshwater, which are very rare areas on the island. Such an operation would require monitoring and surveying after the work is finished to ensure the area is not colonized by invasive or proliferating species.

ANALYSIS OF HUMAN DISTURBANCES AND RECOMMANDATIONS FOR THE CONSERVATION OF HABITATS AND VASCULAR FLORA

Former human disruptions tied to military activities and the permanent occupation of the island over most of the 20th century, greatly altered its plant biodiversity and terrestrial ecosystems, the impacts of which are difficult to measure due to the lack of paleo-environmental studies and ecological history.

6.1. Past human impacts on terrestrial ecosystems

The history of Sazani Island, since its origins, is not well known, but the island has been inhabited since Antiquity. As many other Mediterranean islands, Sazani has gone through successive phases of occupation and abandon, tied to regional geopolitical conditions and to local political contexts. Furthermore, its location as the “gateway to the Adriatic” has given it a premium strategic position for controlling the Otranto Strait and this long coveted sea (Nathanaili, 2002).

In the Middle Ages, it was claimed by the Republic of Venice but defended by the Albanian lords, and was occupied for several centuries by the Ottoman. Notes in the famous portolan *Kitâb-i Bahriye*, written in 1521 by Pîrî Reis (1470-1554) report the presence of drinkable freshwater on the island, probably in abundance; Sazani was then a much appreciated anchoring point for the Ottoman navy. Even though it was claimed in vain by Greece in 1866-1871, it was still part of the Ottoman Empire until the Balkan Wars (Nathanaili, 2002). At the end of the 19th century, its rather unclear geopolitical status could explain its sporadic or non-existent human occupation. During a botanical exploration in 1889, Baldacci (1893) reported that the island was uninhabited and abandoned, but remains of fields and a diversity of ruderal plants showed that cultures had been present about twenty years before: *"I ruderi e le piante predette erano due documenti in favore dell' opinione che Saseno fosse un tempo abitata"*.

Then, the terrestrial environment was seriously disrupted - even extremely disrupted - by the huge impacts due to military activities during the 20th century. The island was occupied by Greece up to 1913 then declared Albanian, but Italy actually occupied Sazani ("Isola di Saseno") until the end of the Second World War. Following the Italian occupation of the Vlora region and therefore of Sazani, from October 1914, the implantation of a military base in 1915 on Sazani led to the creation of the first trails, a lighthouse and various barracks on the very open landscapes, made of low bush formations of low density, through which the practically barren soil was visible as shown in a series of photographs the Italian Marine archives (panel 3).

After the Second World War, the Albanian, Russian and even Chinese Military were present on Sazani Island. The construction of a huge number of bunkers, tunnels, half buried patrol paths, the digging of trenches for defense or for cables, all show the general impacts which seriously altered many parts of the island.

Thus, during most of the 20th century, the multiple human disruptions, as well as those caused by herds, changed the structure, the organization and the dynamics of the ecosystems, particularly that of trees and bushes. Only the communities of the cliffs and rocks appear to have been spared, particularly in the quasi-inaccessible areas over the sea.

But the abandoning of the island by the Albanian military and their families in the mid-1980s determined a new inoccupation phase of the island which has led to the current rapid ecological dynamics.



Panel 3. Photos of Sazani Island during the Italian military occupation, in 1918. a: "Parco minatori"; b: path and barrack construction near the San Nicolo Gulf, on the north-east of the island (photo archives of the MCRR).

6.2. Deposit of debris and waste

There are many areas where debris, rubble and various waste has been deposited, the remains of the military activities, including in the most remote parts of the island; whereas waste tied to past human occupation are mostly located around the ancient village and near the current port, located on the eastern coast. Some of the small cliffs and rocks located under some small forts or bunkers could have been impacted by this long-lasting macro-waste.

All these impacts can only be progressively mended under the framework of a large scale ecological restoration program which should be planned with precision in association with the experts of each component.

Management recommendations:

- Establishing an integrated restoration program in association with all the experts of each component.
- Carefully removing and evacuating from the island the accumulated debris, the solid waste (rubble, metal...) or as a last possible solution, concentrating them in a less biologically valuable area, which should be determined by all the experts.
- Concentrating all the biodegradable waste in one place so that the natural or semi-natural habitats are not altered, particularly those on the coast or the temporarily humid valleys.

6.3. Telluric pollutions

A first analysis of various types of telluric pollution and the main impacted areas was carried out, and showed in certain cases high concentration levels of arsenic, barium, sulfide and strontium (J.-L. Lambeaux, S. beqiraj, F. Borghesi & E. Dinelli). The impacts of these pollutions on the flora and vegetation are currently unknown. In the absence of a specific study, it is therefore very difficult to distinguish potential plant species that could be bio-indicators of these pollutions.

6.4. Pollutions of marine origin

Marine pollution can be of two types:

(i) Macro-waste rejections from the sea which accumulate at the back of beaches or at the end of coves; the accumulation of these plastic or other kinds of waste can asphyxiate the vegetation and block keystone species regeneration in the affected areas. This issue mostly affects the eastern coast of the island, particularly the small beach next to the port on the south side, further back from the beach on the north side of the port; other stone beaches on the eastern coast and coves on the west are also affected by an accumulation of macro-waste.

(ii) Pollution via sea-spray, charged with surfactant detergents or hydrocarbons, which cause the necrosis of halophile or halo-resistant vegetation, including woody sclerophyll species. This type of disruption currently seems to be negligible, as no necrotic vegetation due to polluted seaspray was reported along the coasts of the island.

Management recommendations:

- Regular manual cleaning campaigns should be carried out on the small beaches and coves of the island to remove all the solid macro-waste deposited from the sea. Mechanical cleaning of the accessible beaches on the eastern coast on either side of the port should be proscribed as the impacts on these fragile and small natural areas, rich in significant vegetation and invertebrates would be too serious. Only selective removal of this macro-waste in the presence of an ecologist should be carried out.

6.5. Biological invasions by exotic vegetal species

As on most islands of the world, the small islands of the Mediterranean are often impacted by exotic invasive vegetation which change the species composition, the structure and the functioning of the invaded ecosystems (Pretto *et al.*, 2012).

Despite the strong anthropological impacts of the past, Sazani Island is not currently impacted by biological invasions of exotic plant species: only 21 taxa currently present, i.e. 5.1% of all floristic species, have been classified as exotic, based on a first analysis of phyto-geographic species. (Table 5). We also considered as foreign species common Mediterranean plants that have probably been planted on the island for agricultural purposes: carob trees (*Ceratonia siliqua*), rosemary (*Rosmarinus officinalis*), oleanders (*Nerium oleander*) as they only occupy limited space near ancient habitats or on old fields. The case of the fig tree (*Ficus carica*) is more debatable, but in the absence of phylo-geographical studies on these insular species, and in view of its mostly synanthropic distribution, we consider that it must be part of the foreign species.

Three taxa previously mentioned at the end of the 19th century (tree of heaven, *Ailanthus altissima*, American pokeweed, *Phytolacca americana* and the maritime pine, *Pinus pinaster*) with known invasive capabilities around the world, were not found again.

None of the 21 exotic species present (16 of which were reported for the first time during the two PIM operations) show a significant enough dynamic character or occupy a significant enough area within the natural or semi-natural ecosystems, to be classified as an exotic species with invasive characteristics (= "invasive species"). Around some of the occupied barracks near the port, plants recognized in other places as invasive species were planted: ice plants (*Carpobrotus edulis*) and centuryplants (*Agave americana*), but these taxa don't seem to have colonized the surrounding semi-natural area.

Three taxa located near the port should however be monitored: (i) *Euphorbia maculata* which could threaten the very limited habitat behind the beach occupied by a neighboring taxon the purple spurge (*Euphorbia peplis*) a very rare native species on Sazani; (ii) *Oxalis corniculata* and (iii) *Xanthium* sp. Which both occupy mostly artificial biotopes around the port, but which could also colonize the nearby temporarily humid grasslands and the small area behind the beach south of the port.

Management recommendations:

- Eradicating the few black locust plants (*Robinia pseudoacacia*) present here and there around the old village and near a few constructions further west; even if this tree doesn't seem very dynamic for the moment on Sazani, its expansion in the more humid and fresh sectors of the island is possible as this species invasive capabilities have been proven in other places in the Mediterranean.

- Enlever tous les individus plantés de Griffes-de-sorcière (*Carpobrotus edulis*) et d'Agave (*Agave americana*) près des casernes du port, car un risque d'expansion dans le milieu naturel, notamment sur le littoral est à craindre, d'autant qu'un des agents efficaces de dispersion des graines des *Carpobrotus*, le Rat noir (*Rattus rattus*) (Bourgeois *et al.*, 2005) est bien présent sur l'île (M. Pascal, obs. pers.).

- Limiting the expansion of *Euphorbia maculata*, *Oxalis corniculata* and *Xanthium* sp., in the ecosystems next to the port, with regular manual extractions (without using herbicides); carefully monitoring the expansion of *Euphorbia maculata*, an exotic species from North-America, reported at the end of summer, that threatens the habitat of the rare purple spurge (*Euphorbia peplis*).

-Carrying out a regular "ecological watch" (yearly), particularly near the port and the old village, to check that biological invasions are not starting.

Taxa	Family	First mention	Current status	Location
Agave americana L.	Agavaceae	PIM mission 2012	Planted	Around the harbour
Ailanthus altissima (Mill.) Swingle	Simaroubaceae	Baldacci (1893)	Not present	
Carpobrotus edulis (L.) R.Br.	Aizoaceae	PIM mission 2012	Planted	Around the harbour
Ceratonia siliqua L.	Fabaceae	Hoda & Mersinllari (2000)	Planted and naturalized	Some individuals around the old village
Coronopus didymus (L.) Sm.	Brassicaceae	PIM mission 2012	Naturalized	??
Cupressus sempervirens L.	Cupressaceae	Hoda & Mersinllari (2000)	Planted and naturalized	Several stands around the old village and harbour
Erigeron bonariensis L.	Asteraceae	PIM mission 2012	Naturalized	
Euphorbia maculata L.	Euphorbiaceae	PIM mission 2012	Naturalized and putatively locally invasive	Around the harbour and on the southern beach near the harbour
Ficus carica L.	Moraceae	Baldacci (1893)	Planted and naturalized	Common in the different parts of the island
Juglans regia L.	Juglandaceae	PIM mission 2012	Planted and naturalized	Into the small valley, west of the harbour
Melia azedarach L.	Meliaceae	PIM mission 2012	Planted	Near the old village
Nerium oleander L.	Apocynaceae	PIM mission 2012	Planted and naturalized	Near the old village, notably on some cultural terraces behind the village
Oxalis corniculata L.	Oxalidaceae	PIM mission 2013	Naturalized	Around the harbour
Phytolacca americana L.	Phytolaccaceae	Baldacci (1893)	Not present	
Pinus brutia Ten.	Pinaceae	Hoda & Mersinllari (2000)	Planted and naturalized	Widespread on the western part
Pinus pinaster Aiton	Pinaceae	Baldacci (1893)	Not present	
Populus nigra L.	Salicaceae	PIM mission 2012	Planted	Into the small valley, west of the harbour
Ricinus communis L.	Euphorbiaceae	PIM mission 2013	Planted and naturalized	Around the harbour
Robinia pseudoacacia L.	Fabaceae	PIM mission 2012	Planted and naturalized	Near the old village and some old buildings, west of the village
Rosmarinus officinalis L.	Lamiaceae	PIM mission 2013	Planted and naturalized	Near the old village, on some cultural terraces behind the village
Vinca major L.	Apocynaceae	PIM mission 2012	Planted and naturalized	Near the old village
Vitis vinifera L.	Vitaceae	PIM mission 2012	Planted and naturalized	??
Xanthium sp.	Asteraceae	PIM mission 2012	Naturalized	Around the harbour

Table 5. List of exotic plant taxa mentioned on Sazani island.

PROPOSALS FOR SOME COMPLEMENTARY EXPERTISES AND ECOLOGICAL MONITORING

The two operations in September 2012 and May 2013 dedicated to the study of terrestrial vascular flora and vegetation, allowed to highlight the main floristic, biological and ecological characteristics of Sazani Island and to find certain leads in terms of terrestrial land management. Work still needs to be done to better monitor biodiversity dynamics, and to gain better intrinsic knowledge of it.

The recommendations for additional studies and ecological monitoring of the habitats and flora are the following:

- Priority 1: Establishing a global ecological restoration program for the entire island

Because of the various impacts and the telluric pollution caused by significant military occupation in the past, it is necessary to establish a precise ecological restoration program that would include: (i) the dismantling of constructions considered not recoverable (buildings, military infrastructure...); (ii) the de-polluting of sectors that need it; (iii) doing a cost / benefit analysis in order to launch the various possible ecological restoration operations according to the defined objectives and the available means.

This planning should be carried out in association by the experts of each component (biodiversity, waste management, environmental economy) in order for them to define together the precise objectives and the operation priorities. The challenge will be to facilitate an insular system renaturation, while intervening as little as possible on the ecosystems, and also keeping traces of certain components tied to the recent history of the island's human occupation.

- Priority 2: Establishing the island's terrestrial environmental history

Sazani Island's environmental history is a complex subject, but it should be studied soon, as the island has been subjected to various very important impacts which probably deeply modified the structure, the composition and the dynamic of its ecosystems, except those on the rocks and cliffs. Better knowledge of the past landscapes and ecosystems is key to establishing choices and the general orientation of the island's environmental management.

This retrospective study should include: (i) a part about ecological history (based on the gathering of all documents and reports about the island over the last 150 years), and (ii) a part about paleo-ecology aiming to estimate the type of woody areas existing before humans started intensively using the environment, this approach could be based on the analysis of charcoal contained in the soil (pedoanthracology analysis).

- Priority 3: Better understanding the structure and the composition of localized or vulnerable ecosystems by in-depth typology and medium-term ecological monitoring

It would require finer analysis of the composition of the vegetal communities that seem the most original on the island (marine rocks and cliffs, rocky grasslands, coastal grasslands) and comparing them to similar communities found elsewhere, in order to establish a more precise typology and to suggest a syntaxonomic outline according to sigmatist phyto-sociology.

In parallel, permanent plots should be set up to regularly monitor and reliably quantify ecological dynamics that characterize the most significant habitats of the island: (i) coastal habitats (particularly coastal grasslands with *Allium commutatum*, *Lotus cytisoides* and *Limonium spp.*, and the sandy habitats behind the beaches near the port on the eastern coast) and (ii) the habitats in the maritime rocks and cliffs full of rare species.

These protocols should be integrated in the measures sustained by the PIM Initiative's "sentinel islands" program.

- Priority 4: Study of the rare plant population dynamics

The implementation of specific protocols to monitor rare plant populations should provide interesting management elements in regards to local or global environmental changes that affect the island's ecosystems. The plants chosen to be monitored should be decided according to their vulnerability or their supposed sensitivity to these changes and should include various habitats (relictual humid areas, coastal grasslands, maritime rocks and cliffs).

It seems relevant for example to be able to monitor the population dynamics of certain taxa: (i) a very rare island orchid such as the oriental helleborine *Serapias agg. orientalis* in its rocky grassland habitat on the north-west of the island; (ii) island garlic *Allium commutatum* in open halo-resistant formations; (iii) silver ragwort *Jacobaea maritima* in its unique cliff location on the eastern coast (iv) the Aegean cabbage *Brassica cretica* subsp. *aegea* in contrasted cliff locations, either maritime or more inland.

- Priority 5: Additional surveys or new surveys

The 2012 and 2013 floristic surveys provided data on the vascular flora that can be considered satisfactory (probably around 90% of the total floristic diversity of the island was recorded during these two operations).

However, additional surveys could be carried out to complete and improve the current data:

- Spring surveying to locate precocious species, some of which were not identifiable in Mai 2013 (ex: orchids of the *Orchis* and *Ophrys* genus).

- Maritime cliff surveys, requiring a team of rock climbing experts, to properly analyze the flora and vegetation of these original and significant areas for the island and the biogeographical sector considered.

For the other taxonomic groups more or less tied to the "vegetal domain", operations could be considered to develop knowledge regarding bryophytes, lichens and fungi on the island, these surveys would be interesting to assess this position as a biogeographic crossroad for other components of biodiversity than vascular flora.

Though Sazani Island only has an average floristic diversity of vascular plants (419 reported native species and sub-species, of which 288 are currently present), compared to other Mediterranean islands of equivalent size and altitude, it harbors 8% of Albania's vascular flora on a surface only equivalent to 0.0002% of the country.

The two PIM operations carried out in September 2012 and May 2013 led to the surveying of 306 taxa (species and sub-species), of which 152 were never previously reported on the island.

Sazani's flora and vegetation also have important biogeographical benefits. Indeed, the existence of floristic elements of various origins can be explained by its geographical position, a crossroad between the western and eastern Mediterranean. The habitats in the maritime rocks and cliff turned out to be the most interesting in this regard, with the presence of rare and unknown vegetation, whose populations are often located in the western distribution area limit. Several vascular plants (at least 12 taxa) up till now never reported in Albania, were identified or are currently being identified.

Many new vegetal communities were highlighted. The first comparisons with close continental situations (Karaburuni Peninsula and southern coast of Vlorë), have indeed shown the definite originality of some of Sazani Island's vegetal communities, in particular: (i) the maritime rocks and cliffs with Aegean (*Brassica cretica* subsp. *aegea*), Pawlowski Centaury (*Centaurea pawlowskii*), and bellflowers (*Campanula versicolor*); (ii) the coastal grasslands with island garlic (*Allium commutatum*) lotus (*Lotus cytisoides*), (iii) the rocky grasslands with scutellaria (*Scutellaria rupestris* subsp. *adenotricha*);

54 different vegetal communities, regrouped in 8 major types of vegetation, were recorded on the island and mapped on a sufficient scale (1/5000°) to be used as a base for the habitat management plan of natural and semi-natural terrestrial areas

Although the landscapes and ecosystems in certain areas have been severely impacted by humans due to the multiple military activities on this island of the Otranto Strait, a real "gateway to the Adriatic" (Nathanaili, 2002), native vegetal biodiversity is still relatively unaffected by exotic species and no biological invasion by an invasive plant has been detected. In the absence of any major disruptions over the last few decades, following the abandonment of the island by the military, the global ecological dynamics of the island are tending towards the closing of areas, with the progression of matorrals and the maturing of some forest fragments present. The whole should evolve towards thermophile sclerophile oakwoods on the more superficial soils and towards mixed broadleaf formations with hop hornbeams (*Ostrya carpinifolia*) and South European flowering ashes (*Fraxinus ornus*) in the more mesophile areas. The structures of these wood formations are very different from those of the nearby continent, for example on the Karaburuni Peninsula where Vallona oak forests (*Quercus ithaburensis* subsp. *macrolepis*) are developing, whereas they are totally absent from Sazani Island.

All these elements show the insular particularities of Sazani Island and the benefits of this area in terms of conserving very interesting coastal land heritage, such as its floristic composition, its phyto-geographic species and its vegetal community diversity. In view of the rapid urban progression on the southern Albanian coast and the exponential development of tourism (Miho *et al.*, 2013), Sazani Island could play a key role, as many other Mediterranean islands, to act as an actual biodiversity shelter, crucial for the conservation of coastal terrestrial vegetation and flora of the region, which is of major biogeographical interest on a Mediterranean level, although it remained unknown for a long time.

Therefore, based on the analysis of the vascular vegetation and flora, the terrestrial parts of the island fully deserve to be integrated into the protection perimeter of the Karaburuni - Sazani National Park and its marine protected area (Khasta *et al.*, 2011).

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ANNEXE 1 : LIST OF TERRESTRIAL PLANT COMMUNITIES OF SAZAN ISLAND

This checklist is based upon the "*Plant communities of Albania, a preliminary overview*" (Dring *et al.*, 2002) completed by Brullo *et al.* (2010). Several syntaxonomical corrections were performed using Bardat *et al.* (2004).

[x.x]: reference to the habitat type individualized on the vegetation map.

1. Vegetation of sea-cliffs and maritime rocks

- Perennial maritime grasslands and related herb-rich vegetation of coastal salt-marshes and sea cliffs (Juncetea maritimi Br.-Bl. 1952):
 - Mediterranean damp dune-slack and lagoon margin communities (Plantaginion crassifoliae Br.-Bl. 1952): Junco acuti-Schoenetum nigricantis Géhu *et al.* 1987 (on coastal rocks in Sazan island) [1.1]
- Perennial salt-marsh scrubs (Salicornietea fruticosae Br.-Bl. *et* Tüxen *ex* A. de Bolòs *et* O. de Bolòs 1950):
 - Shady sea-cliff community with perennial Chenopodiaceae splashed by salt spray (Salicornion fruticosae Br.-Bl. 1933): Suaeda vera community on shaded maritime calcareous cliff [1.2]
- Communities of rocks and walls influenced by salt spray from the sea (Crithmo maritimi-Limonietea Br.-Bl. 1952): Open communities of crevices on rocky sea-cliffs much splashed by salt spray (Crithmo maritimi-Limonion Molinier 1934):
 - Crithmo-Limonietum anfracti Mullaj 1989 [1.3]
 - Community of maritime rocks with Limonium anfractum and Capparis orientalis [1.4]
 - Coastal community, lightly ruderal, on flattened area with Limonium anfractum, Euphorbia linifolia and Dittrichia spp. [1.5]
 - Rocky coastal community with Allium commutatum and Lotus cytisoides [1.6]
 - Maritime thermophilous cliffs and rocky slopes with Brassica cretica, Echinops sphaerocephalus and Capparis orientalis [1.7]
 - Community of subhalophilous coastal rocks and cliffs with Inula candida and Campanula versicolor [1.8]
- Ruderal communities of maritime rocks and piedmont of cliffs (Parietarietea judaicae Rivas-Mart. *in* Rivas Goday 1964, Brassicion oleraceae Rivas-Mart. *et al.*, 1999):
 - Ruderal piedmont of shady maritime cliffs with Brassica cretica subsp. aegaea and Parietaria judaica [1.9]

2. Strandline and sand-dune communities

- Pioneer vegetation, mostly of nitrophilous summer annuals, on nutrient-rich detritus of strandlines at the upper tidal limit of sand and shingle beaches (Cakiletea maritimae Tüxen *et* Preising *ex* Br.-Bl. *et* Tüxen 1952):
 - Annual halo-nitrophilous forb communities (Euphorbion peplis Tüxen 1950): Community with Euphorbia peplis [2.1]
 - Ruderal community of upper sandy beach with Glaucium flavum [2.2]
 - Pioneer annual vegetation, only feebly halophytic, of Mediterranean coasts (Thero-Atriplicion Pignatti 1953): Atriplicetum hastati-tataricae Lavrentiades 1963 [2.3]

3. Springs, shoreline and swamp vegetation

- Swamp, fen and marginal vegetation of fresh or brackish waters dominated by graminoids, sedges and forbs in open-water transitions (Phragmiti australis-Magnocaricetea elatae Klika 1941):
 - Vegetation dominated by tall graminoids in standing or gently-moving waters and winter-flooded fens (Phragmiton communis Koch 1926):
 - Community with Typha domingensis (Typhetum angustifoliae Soo 1927 / Typhetum latifoliae Soo 1927) [3.1]
 - Vegetation of freshwater rivelets, springs or ponds:
 - Community of temporary freshwater rivelets with Veronica anagallis-aquatica [3.2]

4. Annual grasslands and weed communities

- Weed communities of agricultural crops, gardens and waste places (Sisymbrietea officinalis Gutte *et* Hilbig 1975):
 - Overgrazed vegetation of abandoned fields on nutrient-poor soils in the Mediterranean area (Hordeion murini Br.-Bl. 1936):
 - Rocky community with Hypericum perforatum [4.1]
 - Rocky community with Dittrichia viscosa and/or Dittrichia graveolens [4.2]
 - Hordeo-Sisymbrietum officinalis Oberdorfer 1952 [4.3]
 - Mediterranean ruderal communities of semi-shaded, nutrient-rich places (Chenopodion muralis Br.-Bl. 1936):
 - Urtico-Ecballetum Oberdorfer 1954 [4.4]

- Annual grasslands on oligotrophic, decarbonate and sandy soils, in inland situation (*Helianthemion guttati* Br.-Bl. 1940)
- ▶ Small grassland with vernal and annual herbs (*Polygonum subspathaceus*, *Trifolium* spp., *Vulpia* sp.)

5. Pseudo-steppes, perennial or rocky grasslands and heaths

- Grasslands and steppes of infertile calcareous or sandy soils, often drought-prone (*Festuco valesiaca*-*Brometea erecti* Br.-Bl. et Tüxen 1949):
- Steppic vegetation with tall grasses (*Chrysopogono-Koelerion splendentis* xx):
- ▶ *Phlomis fruticosa*-*Asphodelus ramosus* community Buzo 1990 [5.1]
- ▶ *Phlomis fruticosa*-*Urginea maritima* community Buzo 1990 [5.2]
- ▶ *Salvio-Phlomidetum fruticosae* Barbagallo, Brullo et Fagotto 1979 [5.3]
- Rocky communities with low chamephytes on infertile soils (*Cisto ladaniferi-Lavanduletea stoechadis* Br.-Bl. 1940):
- ▶ Rocky community with *Teucrium aggr. polium* [5.4]
- ▶ Rocky and lightly ruderal community with *Teucrium aggr. polium*, *Asphodelus ramosus* and *Hypericum perforatum* [5.5]
- ▶ Rocky community with *Scutellaria* (more or less ruderal: with *Dittrichia* spp.) [5.6]
- Mediterranean pseudo-steppes and related perennial grasslands (*Lygeo sparti-Stipetea tenacissimae* Rivas-Mart. 1978):
- ▶ Mediterranean tall tufted grasslands on exposed cliffs mainly on coasts (*Saturejo graecae-Hyparrhenion hirtae* O. Bolòs 1962): Community with *Hyparrhenia sinaica* (*Hyparrhenietum hirtae* Bum 1990) [5.7]
- ▶ Sub-hygrophilous and thermophilous communities on clayey soils with *Arundo plinii* (*Arundion collinae* Brullo et al. 2010): Community with *Arundo plinii* on maritime marl slopes [5.8]
- ▶ Community with *Cephalaria leucantha* and/or *Centaurea pawlowskii* on maritime marl slopes [5.9]

6. Mediterranean forests and matorrals (garrigues, phryganes)

- Hedgehog-heaths and low-growing broom phryganes of the eastern Mediterranean (*Cisto-Micromerietea julianae* Oberdorfer 1954):
- ▶ Eastern Mediterranean xeric and moderately acidophilous shrub communities (*Cistion orientale* Oberd. 1954): *Ericetum manipuliflorae* Oberdorfer 1954 [6.1]
- Sclerophyllous scrub on red soils and limestone (*Rosmarinetea officinalis* Rivas-Martinez et al. 1991):
- ▶ Scrub community with *Cistus incanus* of Balkans and southern Italy (*Cisto-Ericion* Horvatic 1958)
- Low maquis and matorrals in the thermo-Mediterranean area (*Quercetea ilicis* Br.-Bl. 1952):
- Coastal matorrals with Juniper (*Juniperion turbinatae* Rivas-Mart. 1975):
- ▶ Matorral with *Juniperus phoenicea* subsp. *turbinata* (*Pistacio-Juniperetum phoeniceae* Trinajstić 1987) [6.2]
- Mediterranean thermophilous matorrals and pine woodlands (*Oleo sylvestris-Ceratonion siliquae* Br.-Bl. ex Guinocet et Drouineau 1944):
- ▶ *Oleo-Lentiscetum* Molinier 1954 var. *adriaticum* Trinajstić 1977 [6.3]
- ▶ Matorral with *Euphorbia dendroides*, *Olea europaea* and *Pistacia lentiscus*: *Oleo-Euphorbietum dendroides* Trinajstić 1973 (1984) and *Pistacio-Euphorbietum dendroides* Trinajstić 1984 [6.4]
- ▶ *Pistacio lentiscus* and *Myrtus communis* community [6.5]
- ▶ Matorral with *Pistacia lentiscus* and *Quercus coccifera* [6.6]
- ▶ Preforest of *Pinus brutia* with *Pistacia lentiscus* and *Quercus ilex* [6.7]
- ▶ *Pinus brutia* forest [6.8]
- ▶ *Pinus brutia* forest, with reafforested stands of *Cupressus sempervirens* [6.9]
- ▶ Reafforested stands of *Cupressus sempervirens* [6.10]
- Evergreen broadleaf forests in humid Mediterranean areas (*Quercetea ilicis* Br.-Bl. ex de Bolos 1950):
- Evergreen broadleaf forest along the north Mediterranean coasts (*Quercion ilicis* Br.-Bl. ex Molinier 1934):
- ▶ *Orno-Quercetum ilicis* Horvatic 1958 [6.11]
- ▶ *Orno-Quercetum cocciferae* Horvatic 1958 [6.12]
- ▶ Preforest of *Quercus ilex* and *Quercus coccifera* with *Pistacia lentiscus* [6.13]
- ▶ Preforested matorral with *Ostrya carpinifolia* and *Pistacia lentiscus* [6.14]
- Woodlands of swamps, fens and wet pastures (*Querco roboris-Fagetea sylvaticae* Br.-Bl. et J. Vlieger 1937, *Populetales albae* Br.-Bl. ex Tchou 1948):
- *Ulmus* woodlands of swamps, fens and wet pastures (*Populion albae* Br.-Bl. ex Tchou 1948):
- ▶ *Ulmo-Fraxinetum* Markgraf 1932 [6.15]

7. Temperate woodland fringes and scrubs

- Sub-scrub and scrub vegetation, seral to natural broadleaved woodland or along margins of woods and hedges

(*Crataegus monogyna*-*Prunella spinosa* Tüxen 1962):

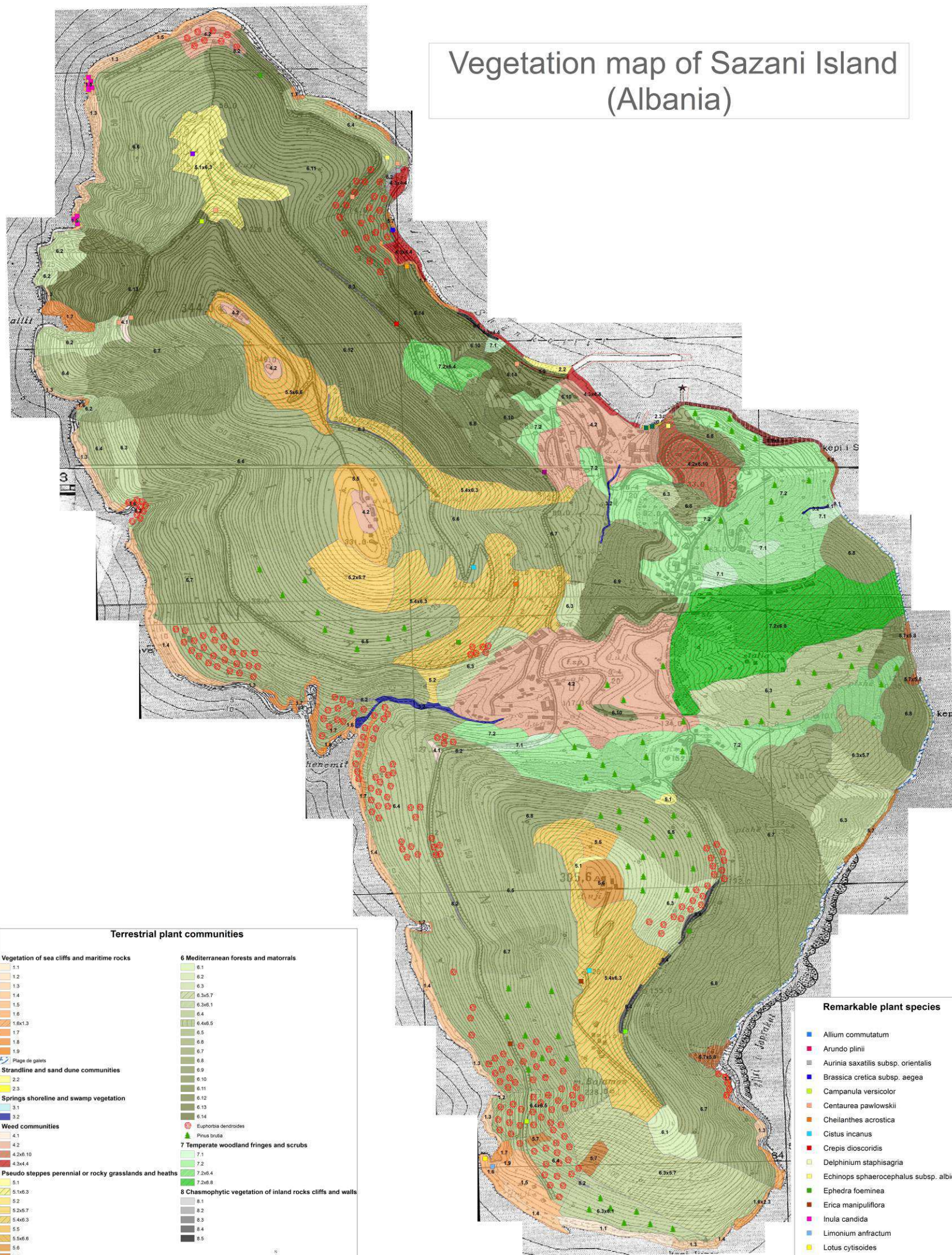
- ▶ Fringes and hedges with *Rubus plicatus* [7.1]
- ▶ Mediterranean post-cultural communities with *Pteridium aquilinum* [7.2]

8. Chasmophytic vegetation of inland rocks, cliffs and walls

- Shaded and humid cliffs and rocks (*Adiantum capilli-veneris* Br.-Bl. 1952): Community with *Adiantum capilli-veneris* and *Samolus valerandi* (*Adiantum capilli-veneris* Br.-Bl. ex Horvatič 1939): ▶ *Eucladio-Adiantetum* Br.-Bl. ex Horvatič 1934 [8.1]
- Open chasmophytic vegetation with ferns and mosses in rock and wall crevices (*Asplenium trichomanes* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberdorfer 1977):
 - ▶ Open chasmophytic vegetation of sunny situations on limestone rocks in the Southern Adriatic (*Campanula trachelium* Quézel 1964): Inland rupicolous community with *Campanula trachelium*, *Centaurea pinnatifida* and *Putzlickia calabrica* [8.2]
 - ▶ Inland rupicolous community with *Asplenium* spp., and/or *Cheilanthes acrostichum* [8.3]
 - ▶ Inland rupicolous community with *Phagnalon rupestre* and/or *Piptatherum caeruleum* [8.4]
 - ▶ Calcareous cliffs with *Cephalaria leucantha* [8.5]
- Wall or rock crevice vegetation at lower altitudes (*Parietaria judaica* Rivas-Mart. in Rivas Goday 1964, *Parietaria judaica*-*Galium murale* Rivas-Mart. ex Rivas Goday 1964):
 - ▶ Rock crevice of temporary wet situations with *Parietaria judaica*, *Selaginella denticulata* (*Parietarium diffusum* Ubrizsy et Penzes 1960) [8.6]
 - ▶ Temporary wet terricolous community on clay soils with *Anogramma leptophyllum*, *Selaginella denticulata* and *Allium subhirsutum*



Vegetation map of Sazani Island (Albania)



Terrestrial plant communities

1 Vegetation of sea cliffs and maritime rocks

- 1.1
- 1.2
- 1.3
- 1.4
- 1.5
- 1.6
- 1.7
- 1.8
- 1.9
- 1.9x1.3

2 Strandline and sand dune communities

- 2.2
- 2.3

3 Springs shoreline and swamp vegetation

- 3.1

4 Weed communities

- 4.1
- 4.2
- 4.2x6.10
- 4.3x4.4

5 Pseudo steppes perennial or rocky grasslands and heaths

- 5.1
- 5.1x6.3
- 5.2
- 5.2x5.7
- 5.4x6.3
- 5.5
- 5.5x6.6
- 5.6
- 5.7
- 5.7x5.8
- 5.8
- 5.9
- 5.9x5.8

6 Mediterranean forests and matorrals

- 6.1
- 6.2
- 6.3
- 6.3x5.7
- 6.3x6.1
- 6.4
- 6.4x6.5
- 6.5
- 6.6
- 6.7
- 6.8
- 6.9
- 6.10
- 6.11
- 6.12
- 6.13
- 6.14

7 Temperate woodland fringes and scrubs

- 7.1
- 7.2
- 7.2x6.4
- 7.2x6.8

8 Chasmophytic vegetation of inland rocks cliffs and walls

- 8.1
- 8.2
- 8.3
- 8.4
- 8.5

Source : F. Médal, L. Chamer, M. Chamer, L. Kashi, CELRL
Révision : septembre 2013 (L. Chamer)

Remarkable plant species

- Allium commutatum
- Arundo plinii
- Aurinia saxatilis subsp. orientalis
- Brassica cretica subsp. aegaea
- Campanula versicolor
- Centaurea pawlowskii
- Cheilanthes acrostica
- Cistus incanus
- Crepis dioscoridis
- Delphinium staphisagria
- Echinops sphaerocephalus subsp. albidus
- Ephedra foeminea
- Erica manipuliflora
- Inula candida
- Limonium anfractum
- Lotus cytisioides
- Ononis mitissima
- Orobanche lavandulacea
- Putoria calabrica
- Salvia sp.
- Selaginella denticulata
- Serapias agg. orientalis
- Vitex agnus-castus