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MOSES project: Maritime, Ocean Sector and Ecosystem Sustainability

Work Package 6: assessing the vulnerability of marine and coastal ecosystems

Action 2: Data processing and construction of synthetic index
Results and rankings

J. Fernández-Macho, P. González and J. Virto

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MOSES
Maritime, Ocean Sector and Ecosystem Sustainability: Fostering Blue Growth in Atlantic Industries

Interreg Atlantic Area
European Regional Development Fund
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Work Package 6: assessing the vulnerability of marine and coastal ecosystems

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Final Report

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Abstract: MOSES project Work Package 6 (WP6: Identify and assess vulnerability) has as its main objective to assess the vulnerability of marine and coastal ecosystems to sectoral pressures from a socio-economic point of view. To do this, WP6 proposes the use of appropriate statistical tools to construct a synthetic index of vulnerability with which to rank European Atlantic Arc countries and regions up to NUTS3 Eurostat geographical level.

This report shows the variables used, as well as their basic indicators and sources, and provides a preliminary analysis of the results obtained. According tho this, it can be observed that, overall, UK has the most vulnerable coast in Atlantic Europe, with Ireland showing the most resilient coast of all. On the whole, however, most of the Atlantic European coast appears to be quite vulnerable.

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Preface

MOSES project Work Package 6 (WP6: Identify and assess vulnerability) has as its main objective to assess the vulnerability of marine and coastal ecosystems to sectoral pressures from a socio-economic point of view. The lead partner for WP6 is the *Institute of Public Economics, University of the Basque Country (UPV/EHU).*

In what follows we will implicitly assume that coastal vulnerability is defined as: "Degree to which coastal areas are susceptible to: damage or degradation due to environmental conditions and impacts caused by sectoral pressures from marine/maritime activities related to maritime transportation, port facilities and coastal socio-economic activities."

WP6 contemplates five (5) vectors of interest with different basic indicators. Namely,

Vector 1: marine spill risk... It aims to identify spill locations in Atlantic European waters and construct a marine spill risk index for the coastal territories in the European Atlantic Arc.

Vector 2: port facilities impact... It contemplates the assessment of vulnerability due to passengers and goods transportation and covers indicators related to sustainability awareness (energy efficiency, land use, etc.).

Vector 3: coastal activities and tourism... It covers indicators related to demographic pressure, tourism and recreation, economic development and land use and infrastructure development.

Vector 4: protection of coastal areas... It is related to EU SCIs (Coastal Sites of Community Importance).

Vector 5: bathing water quality... it assesses Bathing water quality from indicators such as Atlantic European blue flag beaches, waste disposal, etc..

With this database of basic informaton and using appropriate statistical tools (Fernandez-Macho, 2016; Fernández-Macho et al., 2016; Fernández-Macho and González, 2009), WP6 aims to construct a synthetic index of vulnerability with which to rank European Atlantic

Arc countries and regions up to NUTS3 Eurostat geographical level. Partial rankings are obtained on each of the vulnerability vectors and, finally, on an overall aggregated vulnerability index.

Maps depicting the geographical distribution obtained for each vector and the overall index show the results obtained, together with cartograms where the regions' surfaces have been deformed to be proportional to the corresponding scores. Finally, country-level aggregated scores are shown in an appendix.

Later, using the information provided by the Index, WP6 will perform an econometric analysis to assess the relative risk related to marine environments and ecosystems as well as the physical and socio-economic vulnerability of coastal areas.

Base year for the index is 2017, but data were collected from 2014 trough 2017 (except for Vector 1 which is based on all recorded historical spills in European waters from 1970 to 2014 provided by ITOPF) so that some time series analysis can be carried out in the future.

As primary beneficiaries, local and regional governments may use these results as diagnostic tools to assess the relative position of the coastal vulnerability of its region of interest, and to learn about its strengths and weakness so that they can design and carry out appropriate actions.

We hope these objectives will help to analyze and compare the maritime economic importance of different regions in order to better implement the integrated European marine policy.

1 Vector 1: marine spill risk

In the construction of Vector 1 marine spill risk values for MOSES coastal NUTS3 regions were obtained from Fernández-Macho (2016) where a method for the evaluation of marine spill risks is proposed and applied to all European coastal territories. The method uses tools of geographic information systems and computer modelling to simulate the effect of spills at sea. The modelling considers the size of the spill, its distance from the coast, the shape and length of coast that would be affected and the direction and speed of the ocean currents. It was applied to all recorded historical spills in European waters from 1970 to 2014 (ITOPF, 2015) for 429 Eurostat territorial units in 156 European coastal regions.

1.1 Data sources and raw indicators

(see IEP/MOSES-WP6.Act.1/IT2019: Database description.)

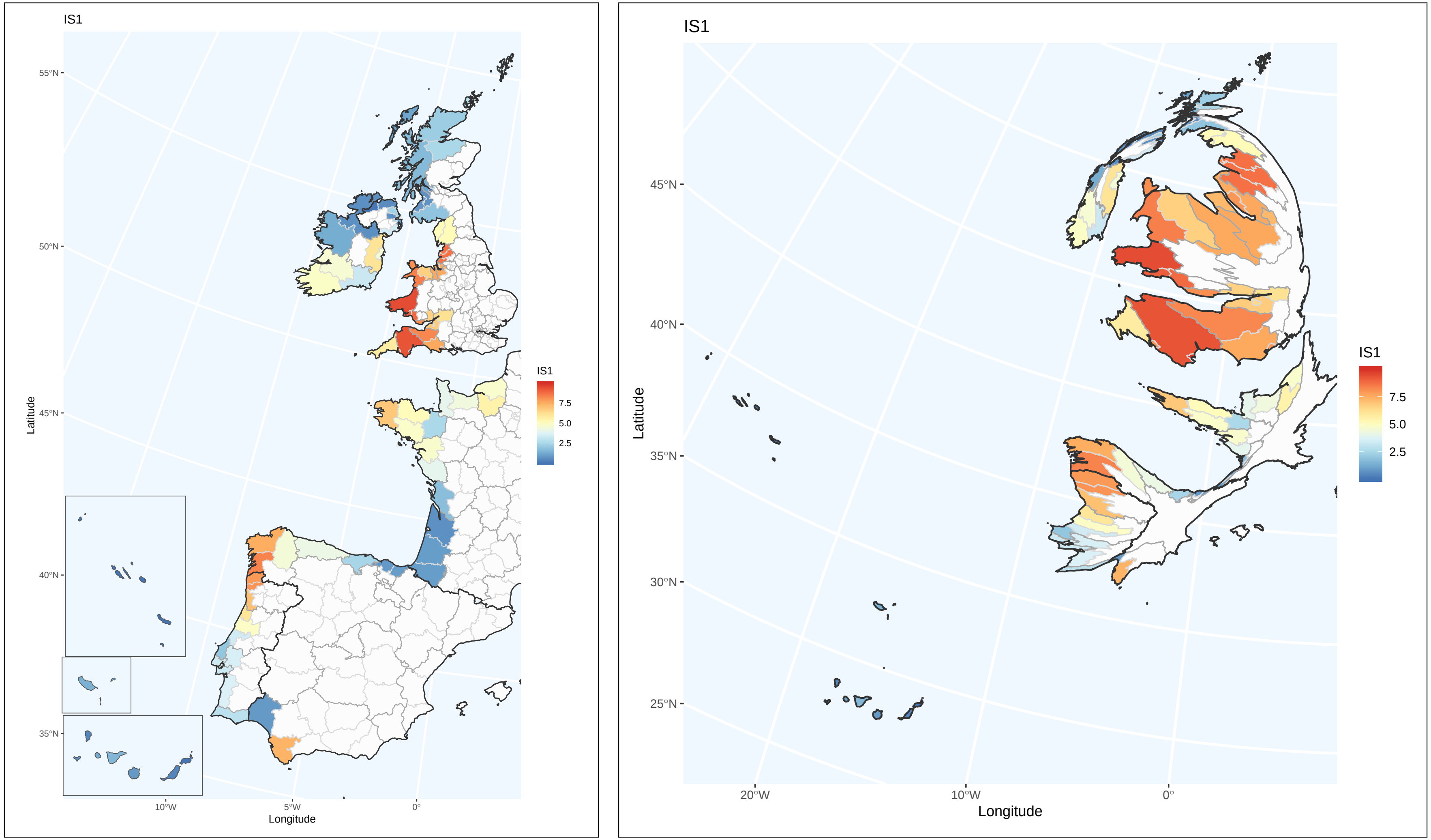
1.2 Indicators

Two of the marine spill risk indicators reported in Fernández-Macho (2016) have been used to construct Vector 1. Namely, the 'currents-free' marine spill risk scores R_{0i} and the final scores R_i that incorporate the effect of sea currents at the time and place of the incident. Figures 1a and 1b show respectively map and cartogram of the geographical distribution obtained for this vector.

1.3 Vector 1 scores

Marine spill vulnerability scores for each of the European waters coastal NUTS3 territories can be seen in Fig. B1. According to this ranking it can be observed that the coastal districts of Wales and the South West of England (UK) are subjected to the highest marine spill risk levels in Atlantic Europe. For example, Torbay in South West England obtains the highest score (9.99/10), followed by South West Wales (9.46) and Swansea (9.06) in Wales and Devon (9.31) in the South West. In fact, there are only three non British coastal territories within the first 25 NUTS3 territorial units most at risk from accidental spills in European coasts; namely, Pontevedra (8.32) and A Coruña (7.49) in North West Spain and Alto Minho (7.92) in Northern Portugal.

Aggregates in Fig. A1 show how, on average, UK and Portugal lead the ranking of marine spill risk scores for countries with coasts in Atlantic European waters. On the other hand, France's and Spain's coastal regions are clearly split by their relative spill risks, with Western regions in Galicia (Spain) and in Bretagne (France) scoring high in contrast with other regions in those two countries.



(a) geo distribution

(b) cartogram with surface proportional to IS1 scores.

Figure 1. Vector 1: marine spill risk.

2 Vector 2: port facilities impact

Shipping has an environmental impact both in ports, as well as in the immediate vicinity of the ports. This vector tries to capture the impact of the port activity on vulnerability. Vector 2 indicators have been obtained from Eurostat and EcoPorts, a environmental initiative of the European port sector fully integrated into the European Sea Ports Organisation (ESPO) since 2011. Figures 2a and 2b show respectively map and cartogram of the geographical distribution obtained for this vector.

2.1 Data sources and raw indicators

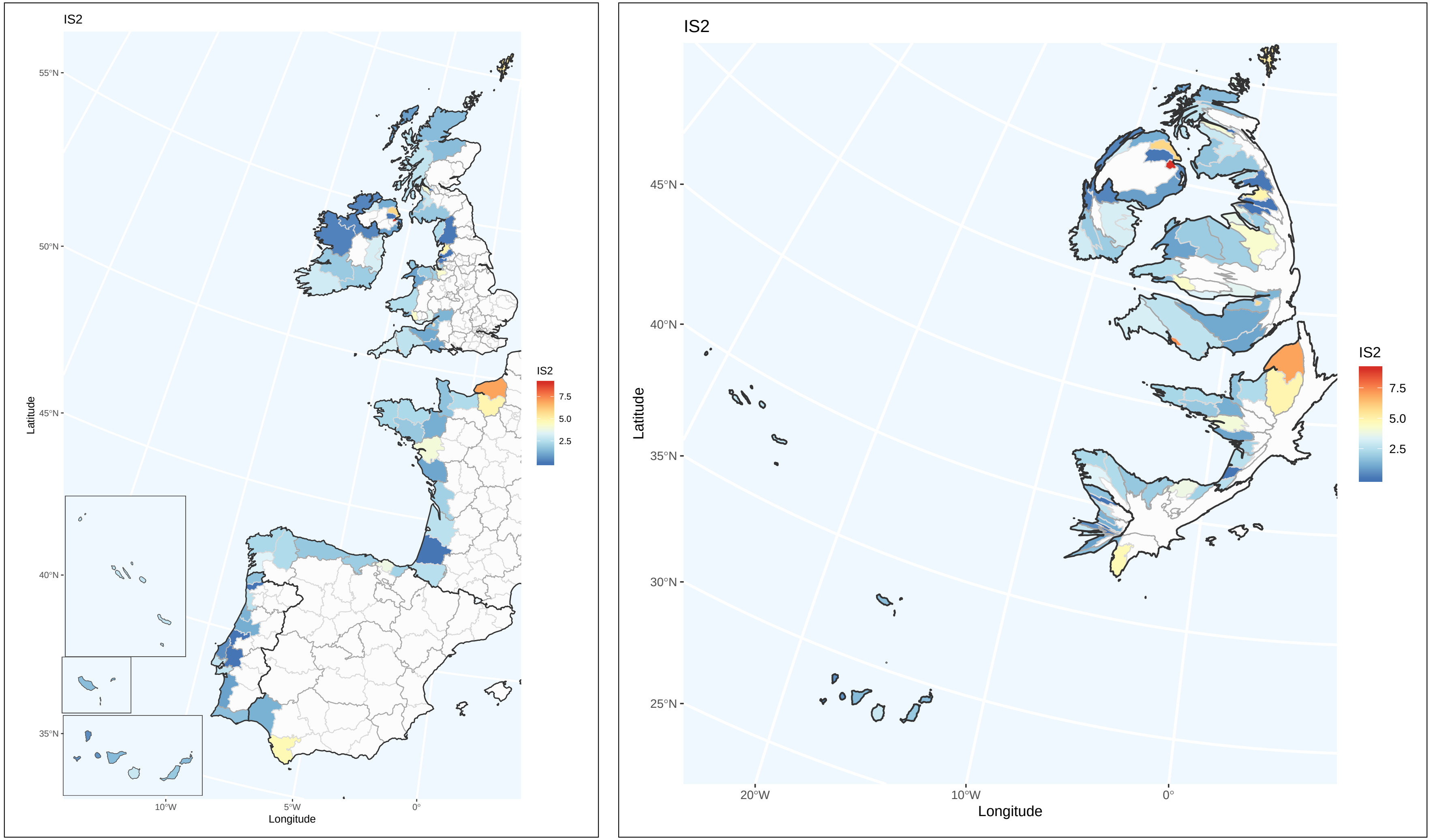
(see IEP/MOSES-WP6.Act.1/IT2019: Database description.)

2.2 Indicators

1. Ports/Coastline: v2.01.pt/v0.06.LC
2. MainPorts/Coastline: v2.04.pmT/v0.06.LC
3. EcoPorts/MainPorts: v2.05.pEco/v0.04.pmT
4. PersPorts/MainPorts: v2.06.pPers/v0.04.pmT
5. AreaPorts/Coastline: v2.07.pArea/v0.06.LC
6. Goods/Coastline: v2.08.pGood/v0.06.LC
7. Passengers/Coastline: v2.09.pPasT/v0.06.LC

2.3 Vector 2 scores

This vector is based on coastal vulnerability due to ports activities. In order to measure the pressure of port activity on the coast seven indicators have been chosen. Five of these indicators, obtained from Eurostat, measure the possible negative impact on both the maritime and terrestrial environment of port operations and activities. The other two indicators collect information on the good environmental practices of ports and their concern for sustainable development. They have been obtained from EcoPorts, a environmental initiative of the European port sector fully integrated into the European Sea Ports Organisation (ESPO) since 2011. Maritime transport and ports is one of the most valuable sector in terms of revenue and employment in the European Atlantic Area. This sector provides vital links for trade and commerce within the Atlantic Arc region and with the rest of European regions and the world. Although maritime transport is widely recognised as the most environmentally sustainable form of transport, the large volume of maritime activity generates a substantial amount of emissions that are harmful to human health and the environment. Even though the importance of this sector is not uniform among the regions of the Atlantic Arc, the results obtained for the aggregate vulnerability index by country are quite homogeneous as far as ports influence is concerned. The results of the index by region show that there are three regions with an outstanding index value. These regions, Belfast, Plymouth and Seine-Maritime, are home to three major ports. Belfast Harbour is Northern Ireland's principal maritime gateway and logistics hub. Around 70% of Northern Ireland's and 20% of the entire island's seaborne trade is handled at the Belfast Harbour every year. Plymouth is one of the UK's most historic ports and is home to Brittany Ferries' services to France and Spain. Finally, the Port of Le Havre is the second largest commercial port in France in terms of overall tonnage and the first in terms of containers traffic. It is linked to Portsmouth by Brittany Ferries. On the other hand, the regions with the lowest index values (less than 0.15) are regions with little or no port presence. The rest of the regions are in an intermediate position, some of them because they have only passenger or freight traffic, such as Liverpool, Bristol,...



(a) geo distribution

(b) cartogram with surface proportional to IS2 scores.

Figure 2. Vector 2: port facilities impact.

3 Vector 3: coastal activities and tourism

This vector captures the impact of human coastal activities on vulnerability. In this framework, we are particularly interested in the tourism sector, which is one of the main economic activities in the coast. Figures 3a and 3b show respectively map and cartogram of the geographical distribution obtained for this vector.

Tourism is an important economic sector due to its contribution to GDP and employment. According to the World Travel & Tourism Council, Tourims generates 10.4% of all global economic activity. It contributes 319 million jobs, representing one in ten of all jobs globally. It is a sector that has been growing faster than the global economy for the last eight years. Europe plays an important role in this sector with 51% of international tourits arrivals and 39% of international tourist revenues. Taking into account the countries included in the European Atlantic Arc, it is worth pointing out that France and Spain are first and second, respectively, in the world ranking of international tourist arrivals, with United Kingdom in the seventh position. With respect to international tourism revenues, Spain and France are second and third in the world ranking, respectively, while United Kingdom occupies the fifth position. Coastal tourism contributes significantly in theses countries. It represents 75.6% of total tourism in Spain, 28% in Portugal, 23% in France, 10% in Ireland and 6% in the United Kingdom (Foley et al., 2014, p.204).

3.1 Data sources and raw indicators

(see IEP/MOSES-WP6.Act.1/IT2019: Database description.)

3.2 Indicators

In order to compute the impact of the tourist activity, we have considered indicators that measure the intensity and density of coastal tourism, both from the demand and the supply side:

1. Tourism Intensity:

$$TI1 = \frac{\text{Arrivals in all accomodations}}{\text{Population}} \quad (1)$$

$$TI2 = \frac{\text{Arrivals in hotels}}{\text{Population}} \quad (2)$$

$$TI3 = \frac{\text{Overnights in all accomodations}}{\text{Population}} \quad (3)$$

$$TI4 = \frac{\text{Overnights in hotels}}{\text{Population}} \quad (4)$$

$$TI5 = \frac{\text{Bedplaces in all accomodations}}{\text{Population}} \quad (5)$$

$$TI6 = \frac{\text{Bedplaces in hotels}}{\text{Population}} \quad (6)$$

$$TI7 = \frac{\text{Food and Beverage establishments}}{\text{Population}} \quad (7)$$

2. Tourism Density:

$$TD1 = \frac{\text{Arrivals in all accomodations}}{\text{Area}} \quad (8)$$

$$TD2 = \frac{\text{Arrivals in hotels}}{\text{Area}} \quad (9)$$

$$TD3 = \frac{\text{Overnights in all accomodations}}{\text{Area}} \quad (10)$$

$$TD4 = \frac{\text{Overnights in hotels}}{\text{Area}} \quad (11)$$

$$TD5 = \frac{\text{Bedplaces in all accomodations}}{\text{Area}} \quad (12)$$

$$TD6 = \frac{\text{Bedplaces in hotels}}{\text{Area}} \quad (13)$$

$$TD7 = \frac{\text{Establishments in all accomodations}}{\text{Area}} \quad (14)$$

$$TD8 = \frac{\text{Establishments in hotels}}{\text{Area}} \quad (15)$$

$$TD9 = \frac{\text{Food and Beverage establishments}}{\text{Area}} \quad (16)$$

3.3 Vector 3 scores

This vector is based on coastal vulnerability due to tourism activities. In order to measure tourism pressure on the coast, we considered seven indicators of tourism intensity and nine indicators of tourism density, both from the supply and the demand side. Both concepts are different and capture different aspects of tourism pressure. The concept of tourism intensity measures tourism demand/supply with respect to population so it can be interpreted as an indicator of social tourist pressure. On the other hand, tourism density measures tourism demand/supply with respect to area so it reflects tourist pressure on the territory.

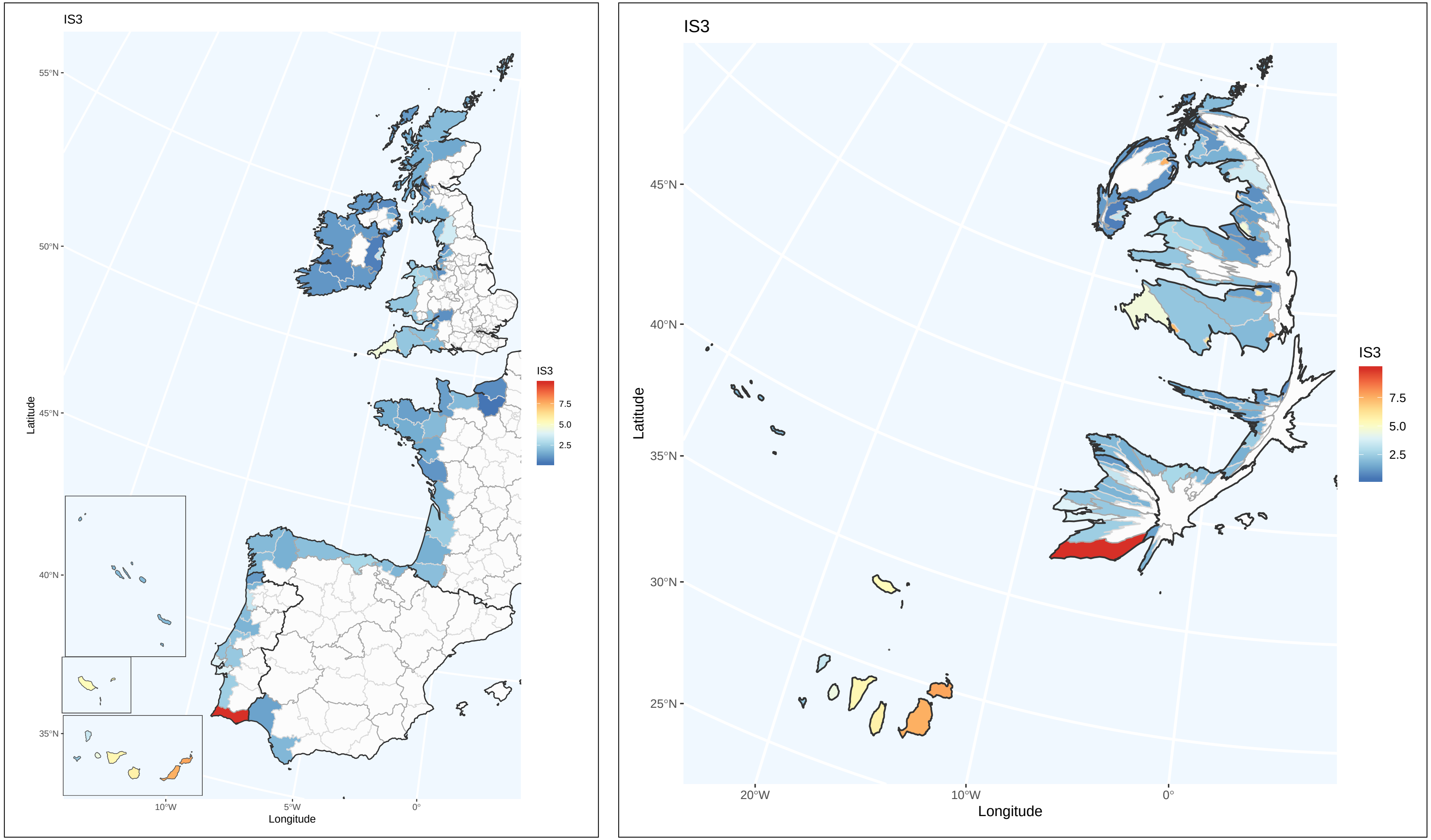
Tourism is an important activity in the countries included in the Atlantic Arc. In fact, some of them are leaders in world tourism. Thus, in the world ranking of international arrivals France and Spain are the leaders while United Kingdom occupies the fifth place. Specifically, World Tourism Organization figures for 2017 are the following: 278 million of tourists for France, 250 million for Spain, 158 million for UK, and then 34 million for Portugal 20 million for Ireland (WTO, 2018). Nevertheless, in order to have an idea of the weight of tourism in the Atlantic Arc, we have to take into account two features. First, the weight of maritime tourism is quite different in these countries: 79% in Spain, 28% in Portugal, 23% in France, 10% in Ireland and 8% in UK (Foley et al., 2014, p.204). Second, that the Atlantic area is not necessarily the most important one within the maritime tourism activity. One example of this is Spain, where the Atlantic Arc tourism represents about 15% of total tourism in Spain (Fernández-Macho et al., 2015). The results of the tourism vulnerability index aggregated by country capture these facts and figures. Thus, Spain occupies the first place followed by Portugal and United Kingdom, while France and Ireland are in the last positions with much smaller indices.

The results of the tourism vulnerability index by region show that the range of the index goes from 0.36 for Eure in France to 9.96 for Algarve in Portugal. Analyzing in detail the regions that occupy the first fifteen positions with indices over 4.5, we may draw the following conclusions:

- We may observe that these first fifteen positions in the tourism index are occupied by 2 Portuguese regions, 4 Spanish regions and 9 UK regions. The Irish region with the highest index is Dublin (22 position) and the first French region is Gironde (28 position).
- The first positions are occupied by Portuguese and Spanish regions representative of what is called "sun and sand" tourism model. Thus, the first one is Algarve, followed in positions 3 and 4 by some Canary Islands regions, Lanzarote y Fuerteventura. Other clear examples of this tourism model are Gran Canaria, Tenerife and Madeira located in positions 11 to 13. Then, we find some of the most important seaside resorts in UK such as Bournemouth and Poole (2nd position) and Plymouth and Torbay in the so called English Riviera (7th and 8th positions). Finally, the NUTS3 regions

given by Belfast, Bristol, Glasgow and Liverpool (positions 5, 9, 13 and 14, respectively) represent another model of tourism, more related to urban tourism.

- We can observe that tourism pressure has different characteristics in these regions. Thus, the weight of the social component of tourism pressure is the highest in two of the less populated Canary Islands, Fuerteventura and Lanzarote, and in two of the most important seaside resorts in UK, Torbay and Plymouth. On the other hand, this social pressure is much smaller in cities like Glasgow, Liverpool and Belfast. Regarding the territorial component of tourism, the regions that suffer the most the tourism pressure correspond to the seaside resorts in the south of UK (Torbay, Blackpool, Plymouth, Bournemoth) and Bristol. This pressure on the territory is much smaller in Algarve, Madeira and Cornwall.



(a) geo distribution

(b) cartogram with surface proportional to IS3 scores.

Figure 3. Vector 3: coastal activities and tourism.

4 Vector 4: protection of coastal areas

Natura 2000 is the largest coordinated network of protected areas in the world. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive. This vector tries to capture the effect of the Natura 2000 network on maintaining the resilience of ecosystems, especially in the marine environment.

Crefmap:V4,map:V4c show respectively map and cartogram of the geographical distribution obtained for this vector. Note that V4 indicators are of "resilience", *i.e.* "minus" vulnerability and, therefore, colours have been reversed accordingly.

4.1 Data sources and raw indicators

(see IEP/MOSES-WP6.Act.1/IT2019: Database description.)

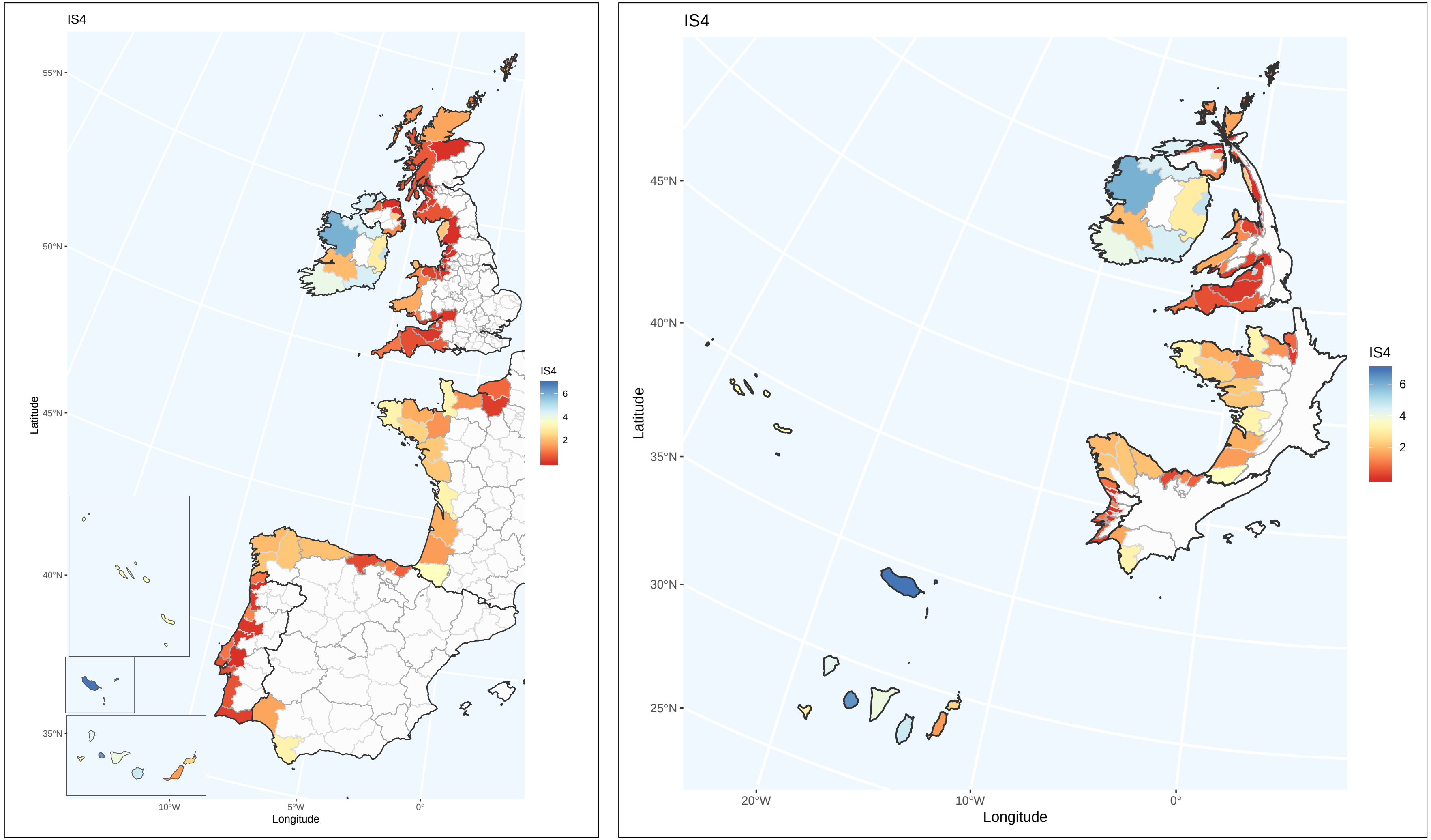
4.2 Indicators

1. n2kSites/Area: v4.01.n2tn/v0.02.surf
2. n2kArea/Area: v4.02.n2ts/v0.02.surf
3. n2kMarineSites/Coastline: v4.03.n2mn/v0.06.LC
4. n2kMarineArea/Coastline: v4.04.n2ms/v0.06.LC

4.3 Vector 4 scores

This vector tries to capture the effect of the Natura 2000 network on maintaining the resilience of ecosystems, especially in the marine environment. In order to measure the effect of protected areas on the marine environment four raw indicators were chosen, weighted by the length of the coastline or the area of the region, which gave rise to the four final indicators on which the vulnerability index was calculated. If we analyze the results by country, Ireland appears with the highest level of protected areas, followed by Spain thanks mainly to the protected areas of the Canary Islands. As for the analysis of the regions, in addition to the Irish regions and the Canary Islands, the island of Madeira and the region of Bristol, where the largest coastal plain estuary of the United Kingdom's is located (the Severn estuary) stand out.

These regions have a high level of protection, both marine and terrestrial, which explains the high values of the index. The regions with the lowest level of protection are located mainly in UK and Portugal.



(a) geo distribution

(b) cartogram with surface proportional to IS4 scores.

Figure 4. Vector 4: protection of coastal areas.

5 Vector 5: bathing water quality

This vector uses information from two European directives: the Bathing Water Directive (76/160/EEC, 2006/7/EC) which aims "to preserve, protect and improve the quality of the environment and to protect human health" and the Waste Framework Directive (75/442/EEC , 2008/98/EC) whose essential objective is "the protection of human healthand the environment against harmful effects caused bythe collection, transport, treatment, storage and tipping of waste".

Figures 5a and 5b show respectively map and cartogram of the geographical distribution obtained for this vector. Note that some V5 indicators are of "resilience", *i.e.* "minus" vulnerability (namely V5.02.bwe, V5.03.bwg ,V5.08.Wef, V5.09.Wref in the list below), and have been multiplied by -1 accordingly.

5.1 Data sources and raw indicators

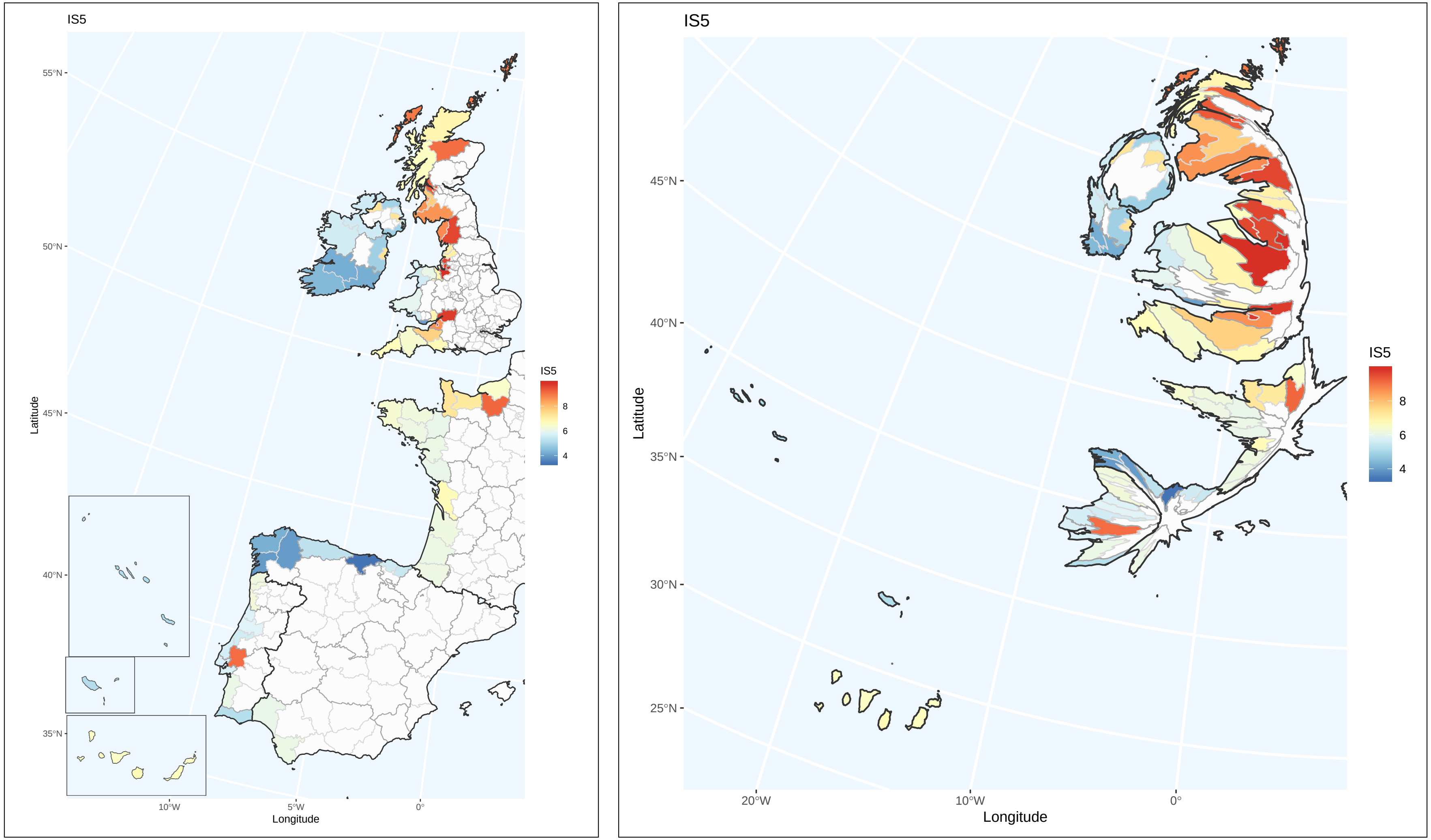
(see IEP/MOSES-WP6.Act.1/IT2019: Database description.)

5.2 Indicators

1. BathingPlaces/Coastline: v5.01.bwt/v0.06.LC
2. ExcellentBP/BathingPlaces: v5.02.bwe/v5.01.bwt
3. SufPoorBP/BathingPlaces: (v5.04.bws+v05.05.bwp)/v5.01.bwt
4. IncinerationF/Population: v5.06.Wif/v0.01.pop
5. LandfillF/Population: v5.07.Wdf/v0.01.pop
6. EnergyRF/Population: v5.08.Wef/v0.01.pop
7. RecyclingRF/Population: v5.09.Wref/v0.01.pop

5.3 Vector 5 scores

This vector is based on coastal vulnerability due to human effects. In order to measure these pressures this vector uses information from two European directives, the Bathing Water Directive and the Waste Framework Directive. Seven raw indicators have been chosen, four of them measure the waste generation and treatment operations and the other three indicators collect information on the quality of bathing waters. Therefore, vulnerability is related to both bathing water quality and waste pressure. The best results of the aggregated vulnerabilty index by country are for Ireland while the highest values of the index are found for UK and Portugal. Analyzing the results by region we obtain the following conclusions. Higher vulnerability is related to two differentiated situations: regions with low or negative bathing water quality and/or regions subjected to considerable waste pressure. These kind of regions are mainly located in the UK and Dublin. On the opposite side we find regions with high bathing water quality and low waste pressure, such as the regions of northern Spain, most Irish regions except Dublin, some Northern Ireland regions and the Portuguese islands.



(a) geo distribution

(b) cartogram with surface proportional to IS5 scores.

Figure 5. Vector 5: bathing water quality.

6 Overall sinthetic index of vulnerability

A final aggregated vulnerability index was obtained by combining all the partial indices belonging to each of the five vectors with V4 scores multiplied by -1 since Vector 4 indicators are of "resilience" rather than of "vulnerability". Figures 6a and 6b show respectively map and cartogram of the geographical distribution obtained for this vector. As can be seen, except for most of Ireland, the Atlantic European coast appears in redish colours corresponding to higher values of vulnerability.

6.1 Overall scores

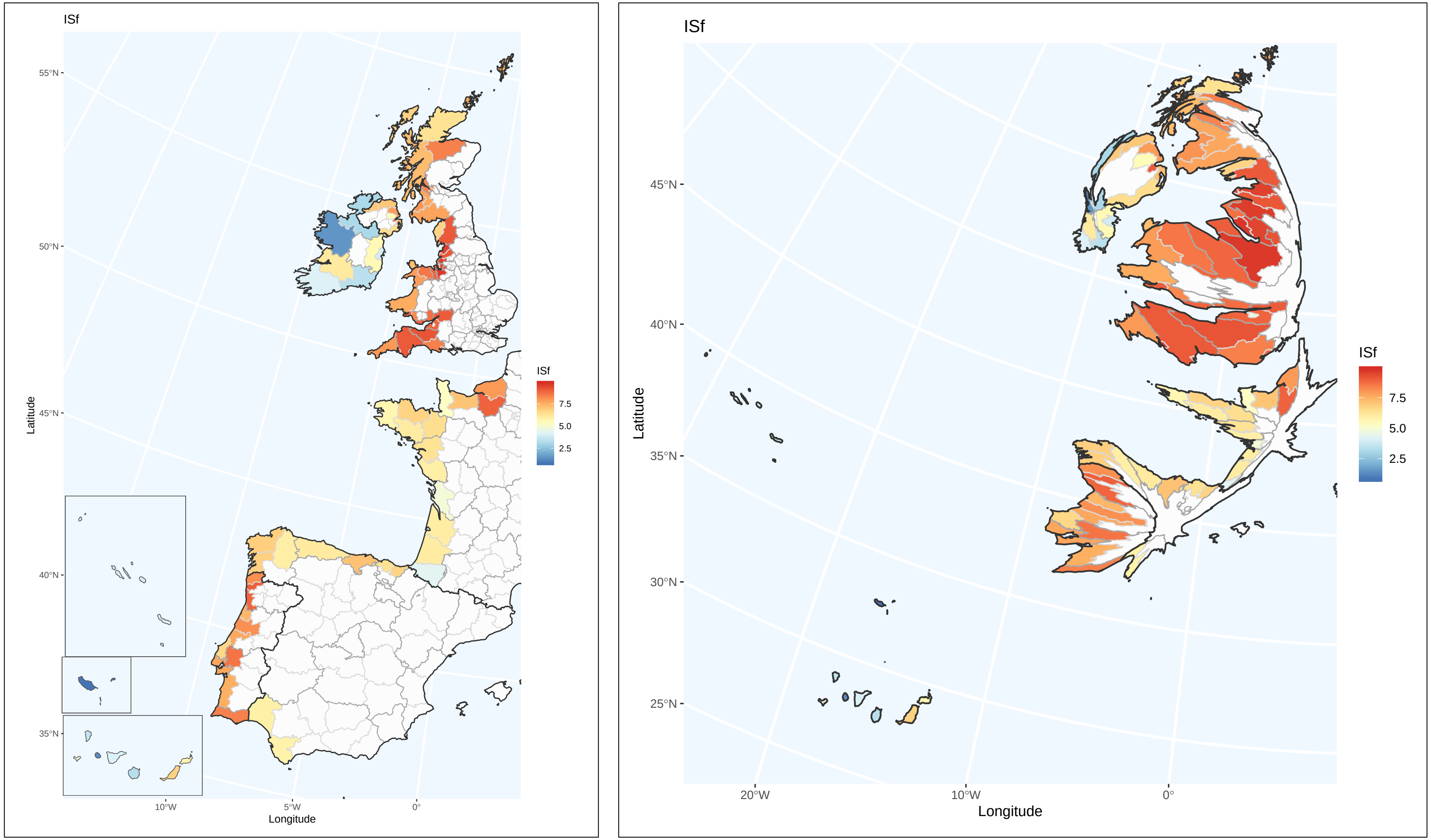
The cartogram represented in Figure 6b illustrates the relative vulnerability of the Atlantic European coast by scaling the surface area of each NUTS3 region in proportion to its vulnerability index score. As can be seen the regions with the greatest vulnerability (10% quantile) belong exclusively to United Kingdom (see the overall ranking in Figure B6). In fact, in the first quarter all but three, Cávado (17th) and Porto (22nd) in Portugal and Eure in France (18th), are on the British coast.

More specifically, on a scale of one to ten, the UK regions of Plymouth, Liverpool (9.8), Cheshire West and Chester (9.7), Chorley and West Lancashire (9.6), Lancaster and Wyre, Blackpool, East Merseyside (9.5), Warrington, Somerset and Mid Lancashire (9.2) lead the overall coastal vulnerability ranking, with six more with a score greater than 9.0. In contrast, the rest of Atlantic European countries have no regions with such high score. For example, the highest scores in Portugal belong to Cávado (just below 9.0) and Porto (8.9), in France to Eure (8.9) and Seine-Maritime (7.9), in Spain to Cantabria (7.1) on the Bay of Biscay coast, A Coruña and Pontevedra (6.8) on the Galician coast and Fuerteventura (6.8) in the Canary Islands, and in Ireland the highest score corresponds to Mid-West (6.1) in the 72nd position.

By countries, the average scores are UK 8.2, Portugal 7.1, France 6.2, Spain 5.4 and Ireland 4.0 (see the country-level bar plots in Figure A6), with an overall Atlantic European average of 7.1. A fuller comparison between countries showing nationwide heterogeneity may be visualized using so-called violin plots, a combination of a two-sided rotated kernel density plot with a box-and-whisker plot inside showing the interquartile range (box) and data points at 1.5 times the box length (see Figure 7).

In this respect, UK shows a vulnerability score distribution quite compact and biased towards high values, while Portugal, in spite oh having an average score just marginally higher than for the whole European Atlantic area, is the country with the highest regional heterogeneity with a sustantial proportion of regions above the Atlantic European average, but with a large variation due to the lowest vulnerabilities shown in Madeira (0.8) and Açores (4.0). Similarly, Spain, although with most regions below the Atlantic European average except marginally the above mentioned Cantabria region, shows a large variation due to the relatively low vulnerabilities of all the Canary Islands.

In summary, it can be concluded that within the European Atlantic Arc, the country with the most vulnerable coast is UK, where most regions are above the Atlantic European average. On the other hand, the country with the least coastal vulnerability is Ireland, with a quite compact distribution of all its regions well below the Atlantic European average. Nevertheless, considering the whole picture, most of the Atlantic European coast appears to be quite vulnerable.



(a) geo distribution

(b) cartogram with surface proportional to overall scores.

Figure 6. Overall sinthetic index of vulnerability.

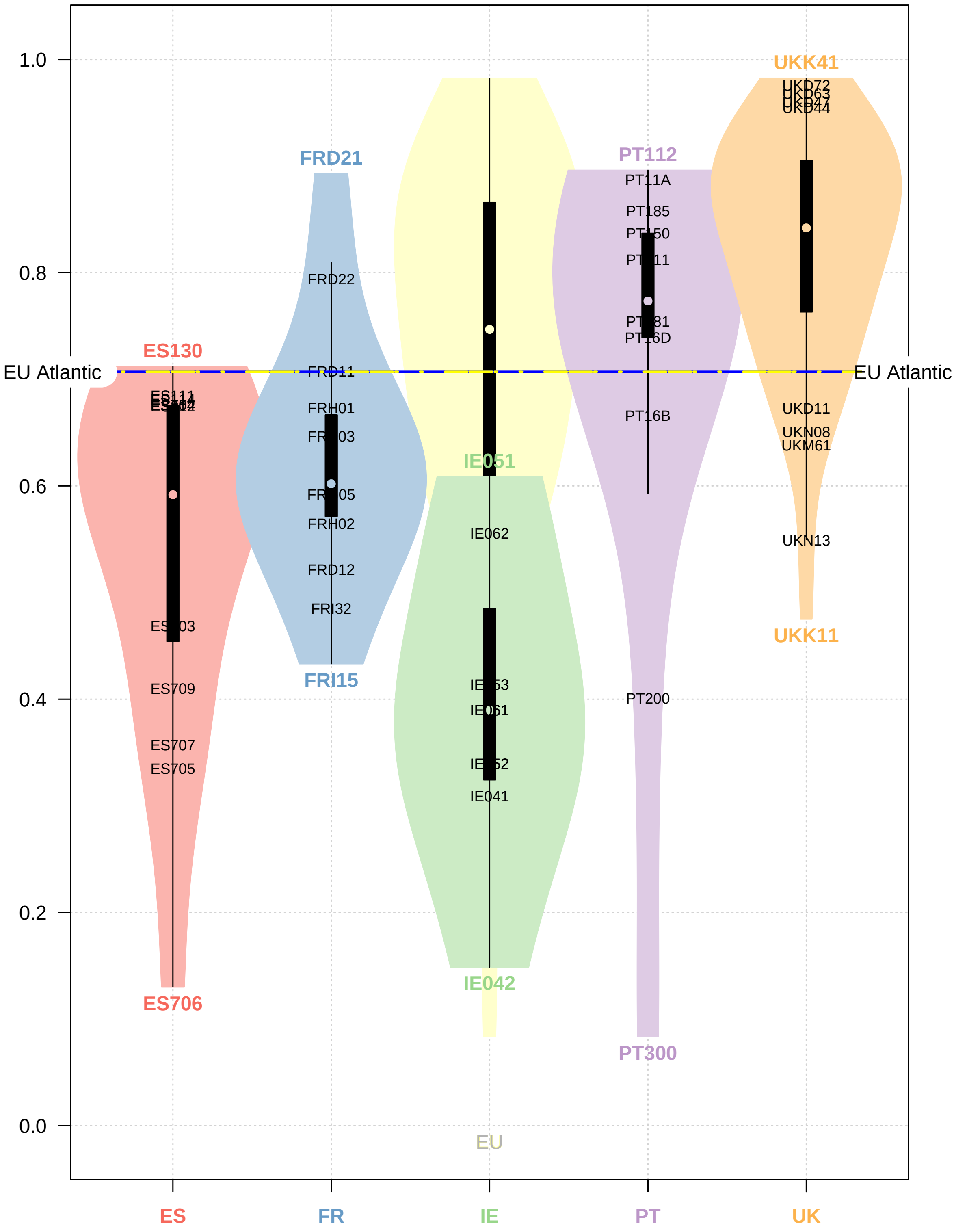


Figure 7. Overall sinthetic index: violin plots.

References

Fernández-Macho, J., 2016. Risk assessment for marine spills along European coastlines. Marine Pollution Bulletin 113, 200–210. doi:10.1016/j.marpolbul.2016.09.015.

Fernandez-Macho, J., 2016. A statistical assessment of maritime socioeconomic indicators for the European Atlantic area. Journal of Ocean and Coastal Economics 2, Article 4. doi:10.15351/2373-8456.1047.

Fernández-Macho, J., González, P., 2009. Evaluación de Territorios Inteligentes en la Sociedad del Conocimiento. Netbiblo. doi:10.4272/978-84-9745-362-2. ISBN: 978-84-9745-362-2.

Fernández-Macho, J., González, P., Virto, J., 2016. An index to assess maritime importance in the European Atlantic economy. Marine Policy 64, 72–81. doi:10.1016/j.marpol.2015.11.011.

Fernández-Macho, J., Murillas, A., Ansuategi, A., Escapa, M., Gallastegui, C., González, P., Prellezo, R., Virto, J., 2015. Measuring the maritime economy: Spain in the European Atlantic arc. Marine Policy 60, 49–61. URL: http://www.sciencedirect.com/science/article/pii/S0308597X15001438, doi:http://dx.doi.org/10.1016/j.marpol.2015.05.010.

Foley, N., Corless, R., Escapa, M., Fahy, F., Fernandez-Macho, J., Gabriel, S., Gonzalez, P., Hynes, S., Kalaydjian, R., Moreira, S., Moylan, K., Murillas, A., O'Brien, M., Simpson, K., Tinch., D., 2014. Developing a comparative marine socio-economic framework for the European Atlantic area. Journal of Ocean and Coastal Economics 1, Article 3. doi:10.15351/2373-8456.1007.

ITOPF, 2015. Oil tanker spill statistics. http://www.itopf.com.

WTO, 2018. Compendium of Tourism Statistics dataset. Technical Report. UNWTO. Madrid. URL: https://www.e-unwto.org/toc/unwtotfb/current.

Appendix A: Bar plots of country-level aggregated vulnerability Index

Aggregation method: unweighted average of NUTS3 values.

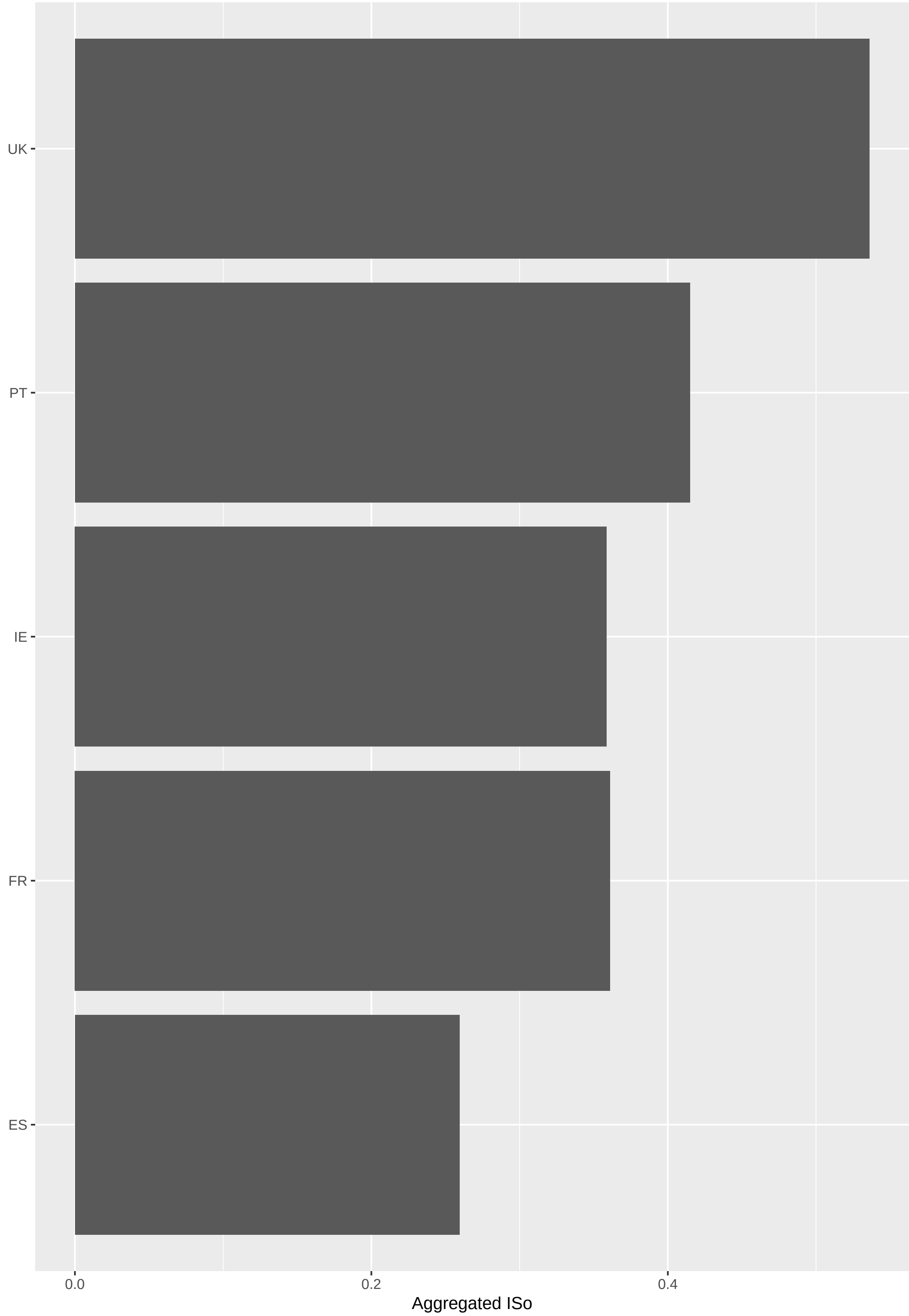


Figure A1. Vector 1: marine spill risk

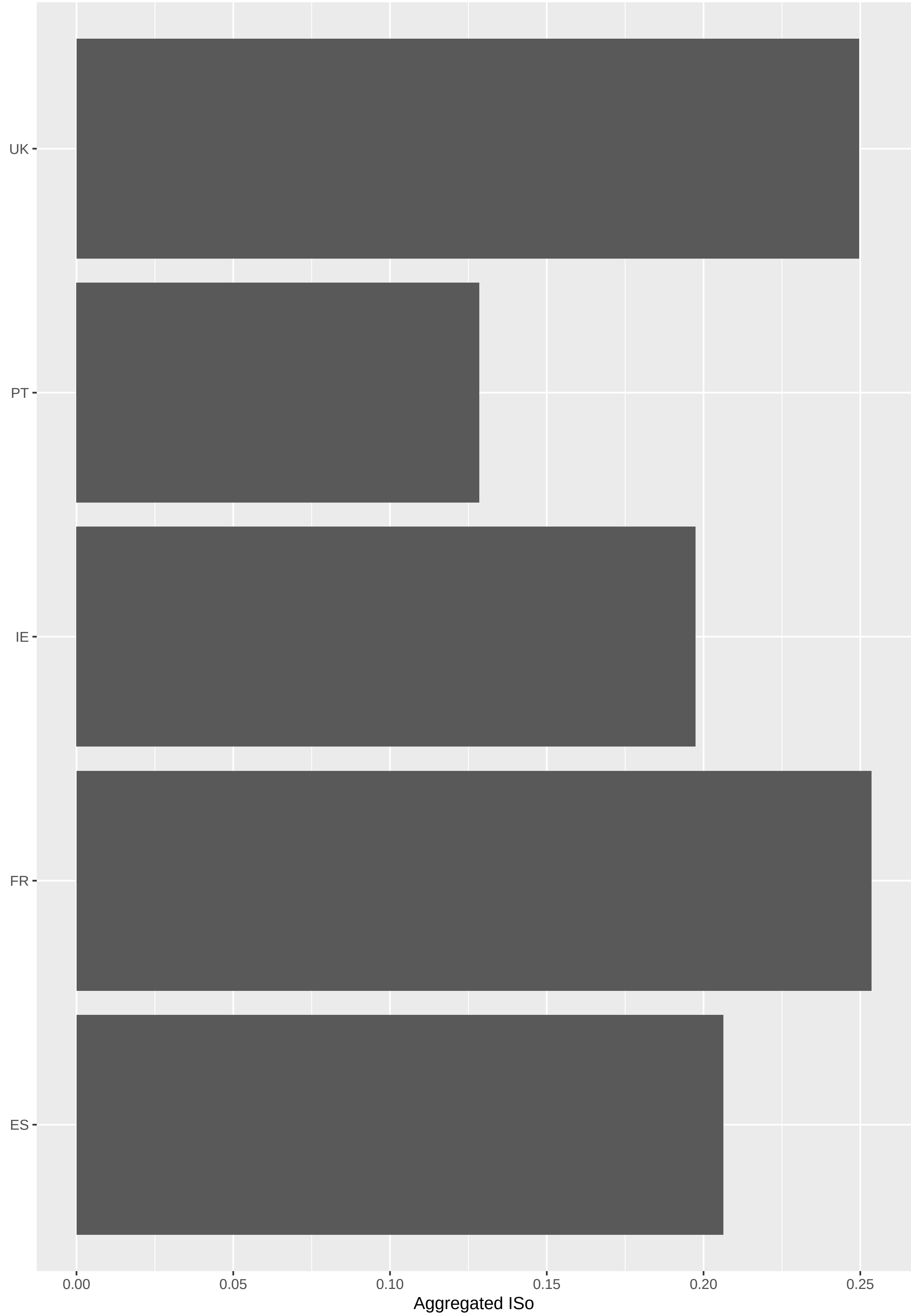


Figure A2. Vector 2: port facilities impact

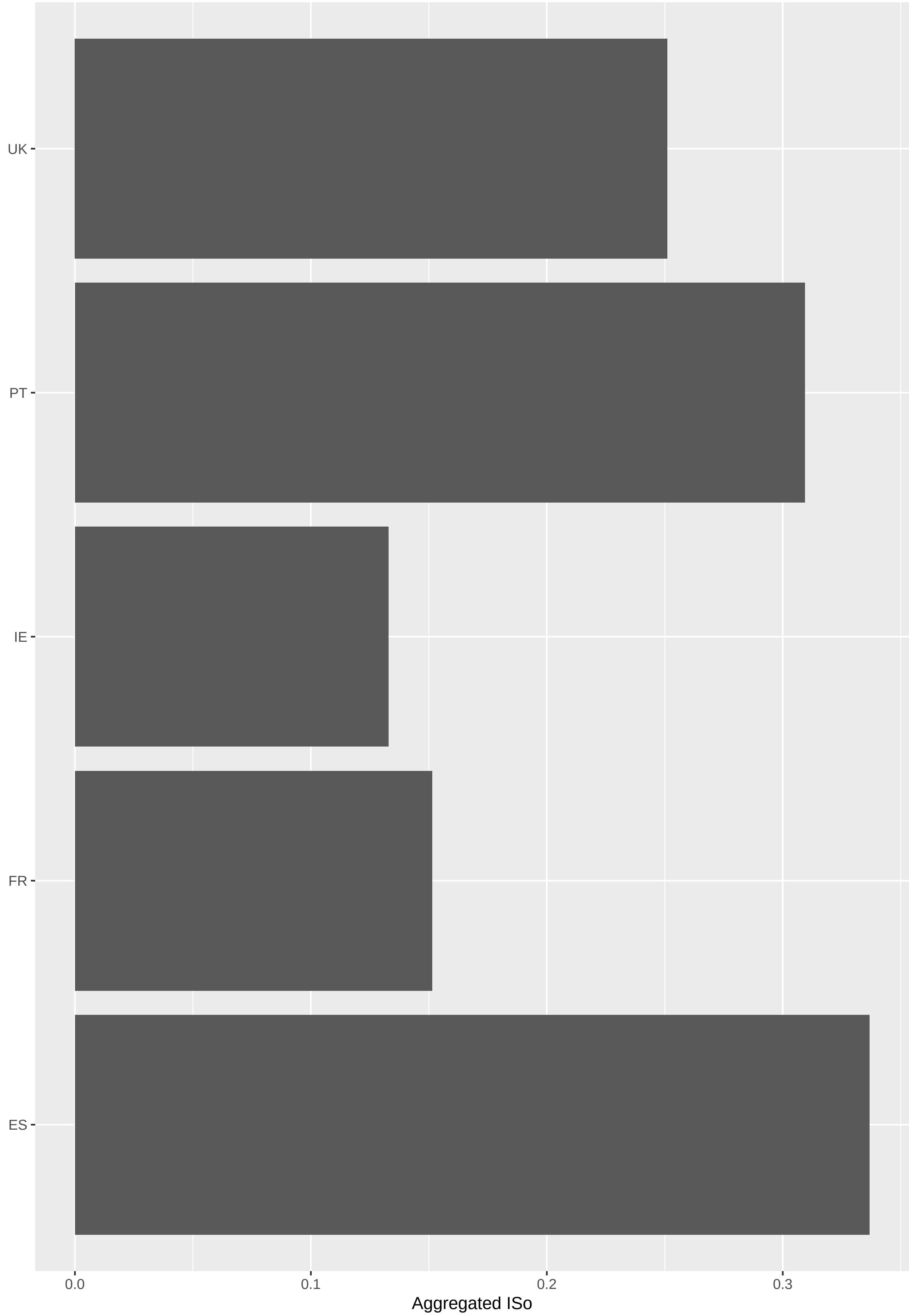


Figure A3. Vector 3: coastal activities and tourism

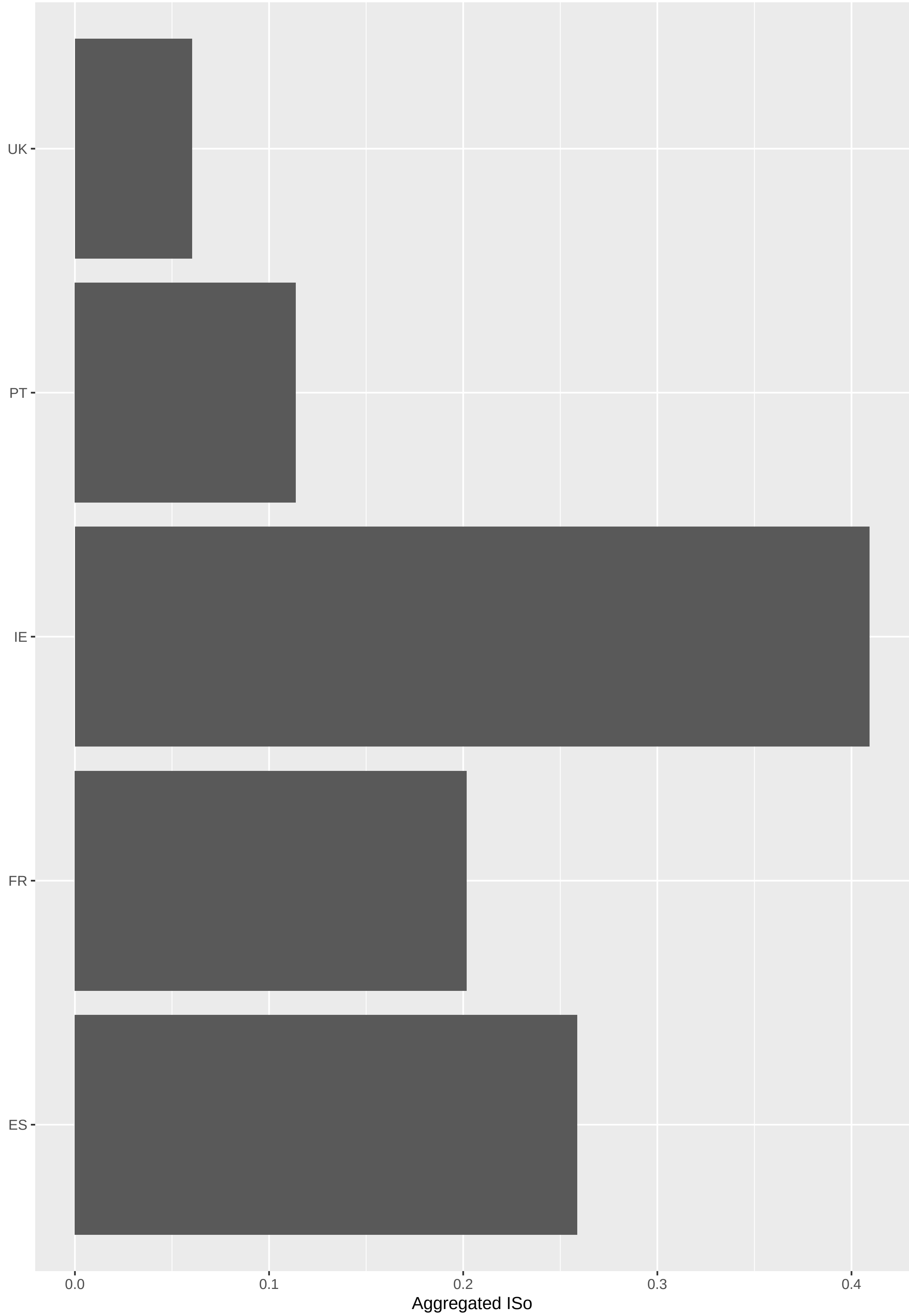


Figure A4. Vector 4: protection of coastal areas

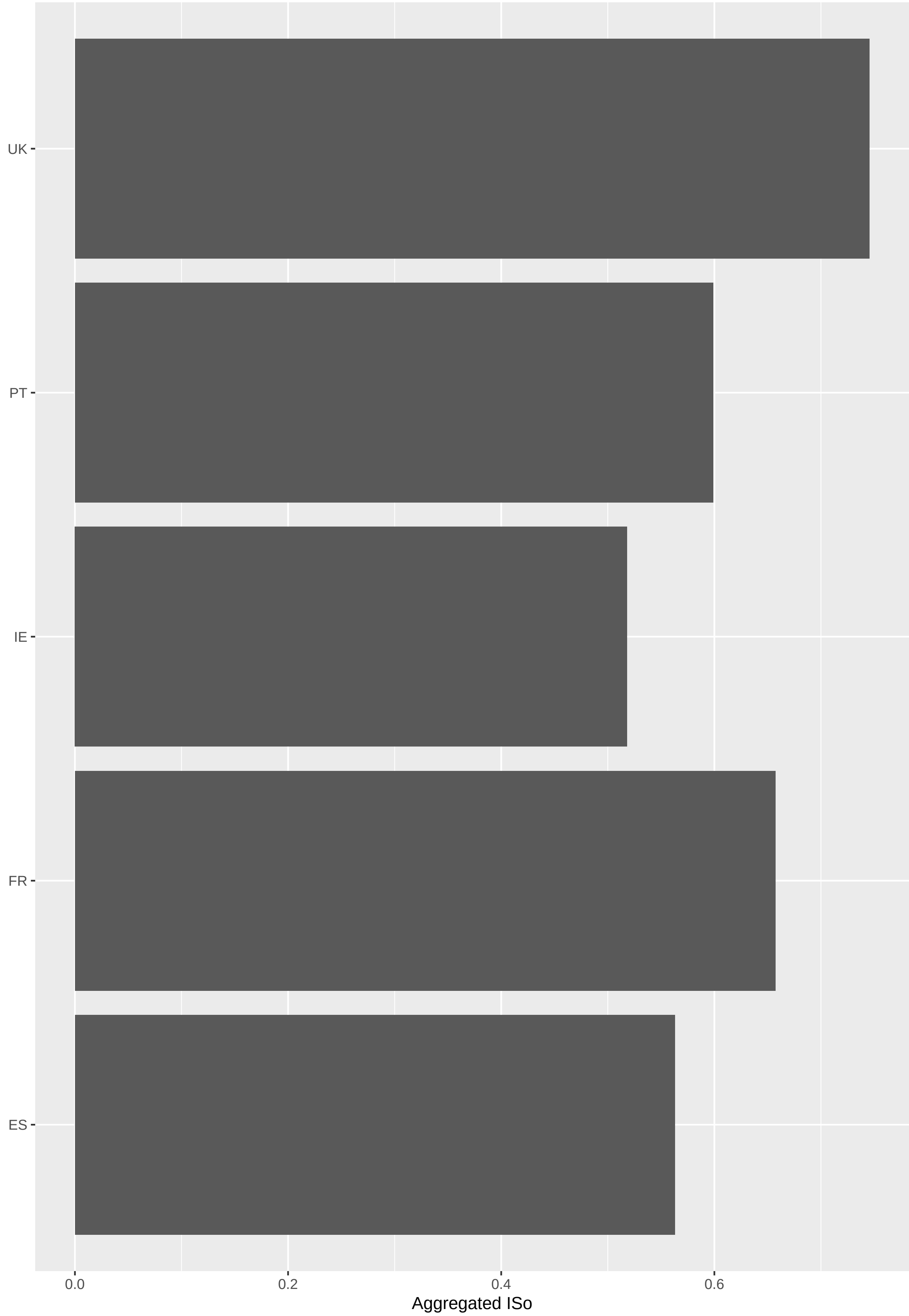


Figure A5. Vector 5: bathing water quality

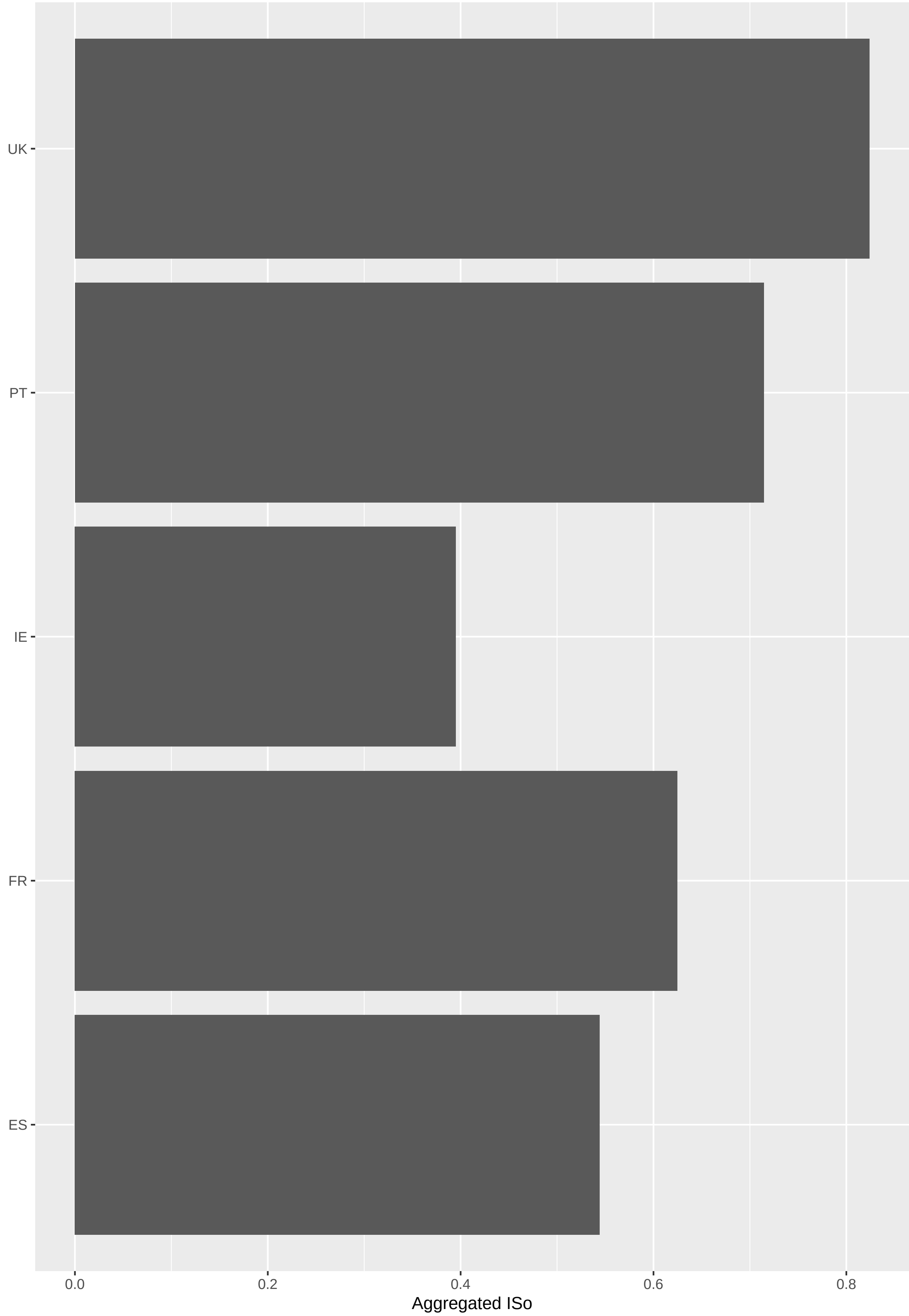


Figure A6. Overall sinthetic index

Appendix B: Bar plots of NUTS3-level vulnerability Index (ranking)

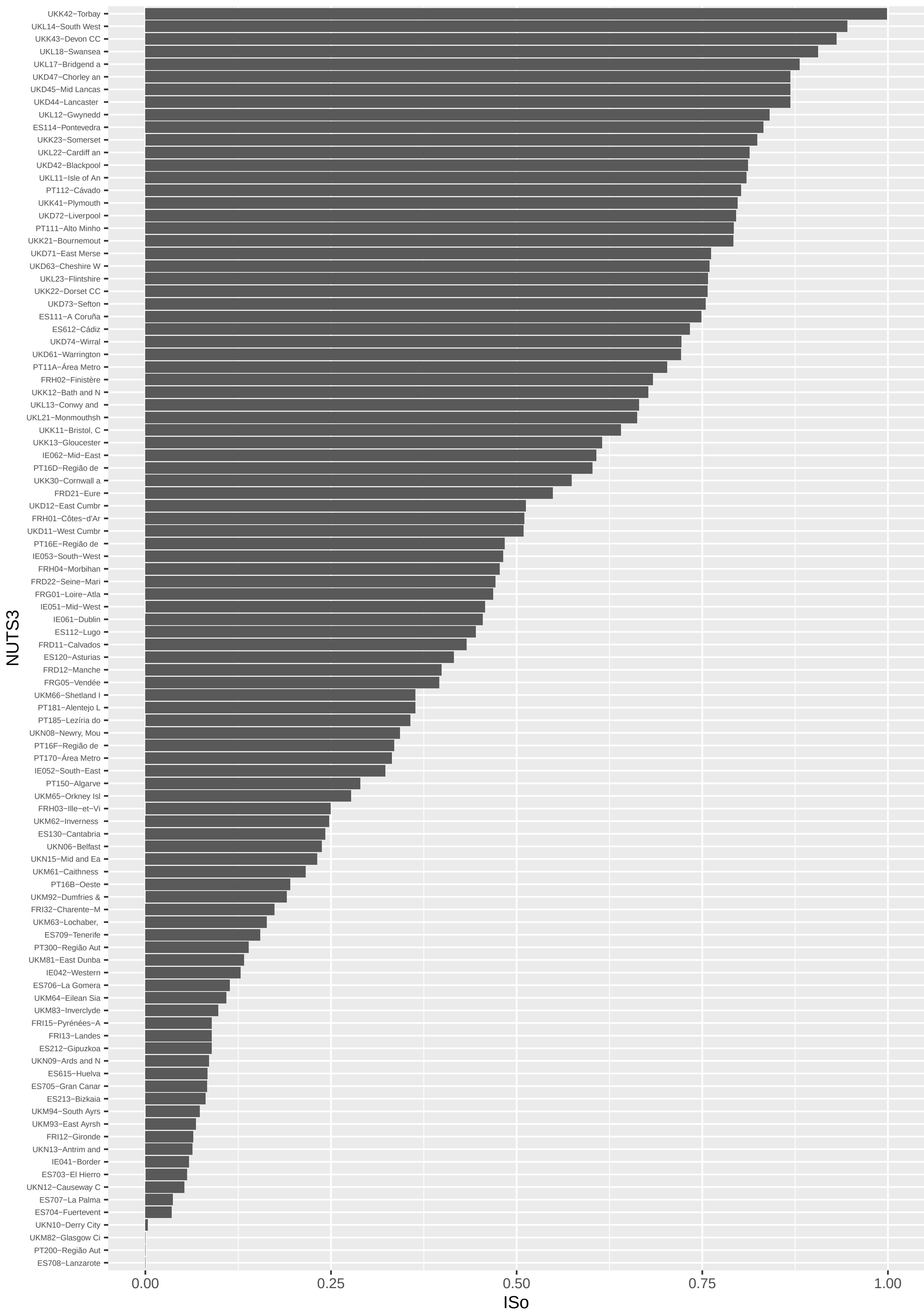


Figure B1. Vector 1 ranking: marine spill risk

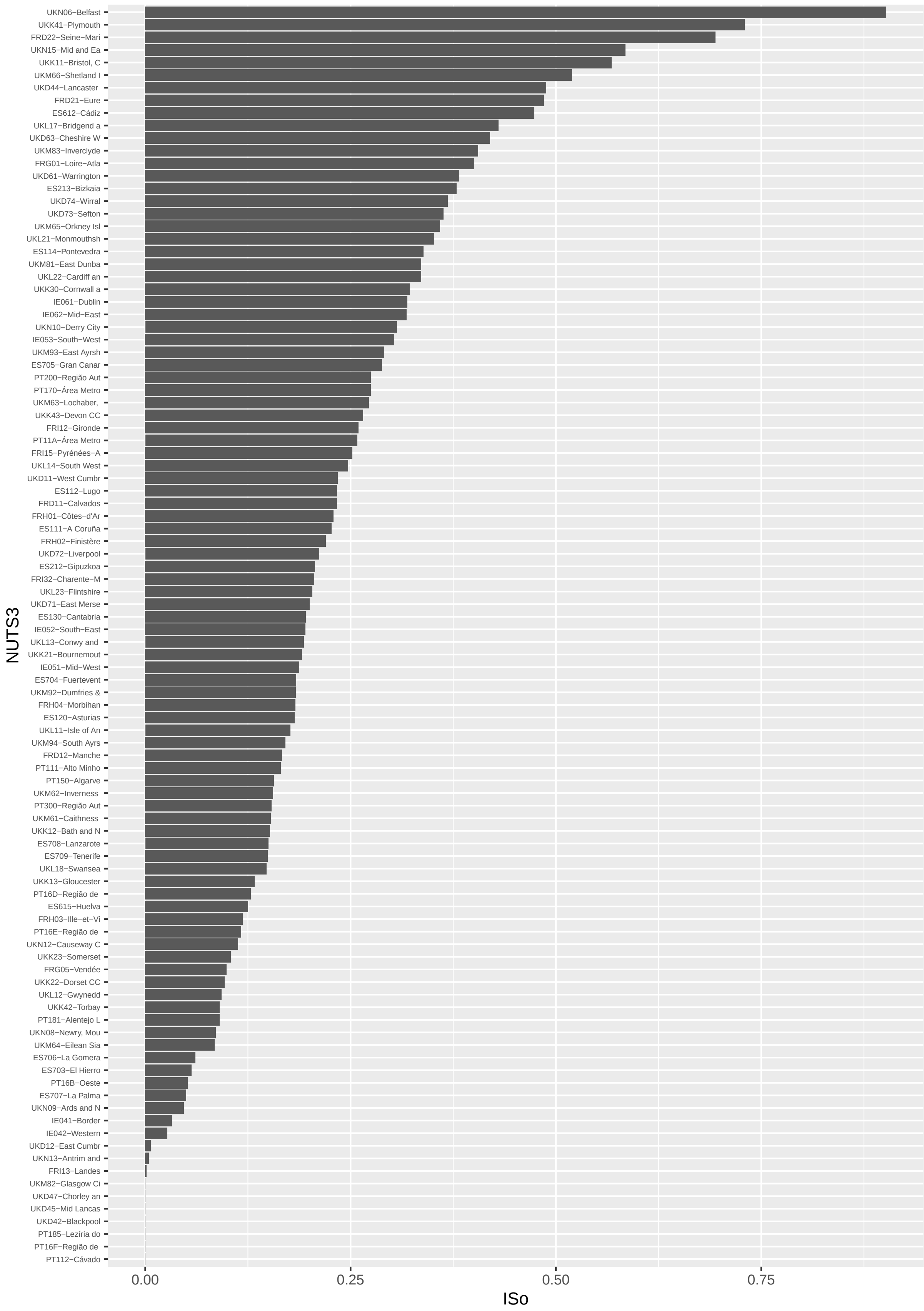


Figure B2. Vector 2 ranking: port facilities impact

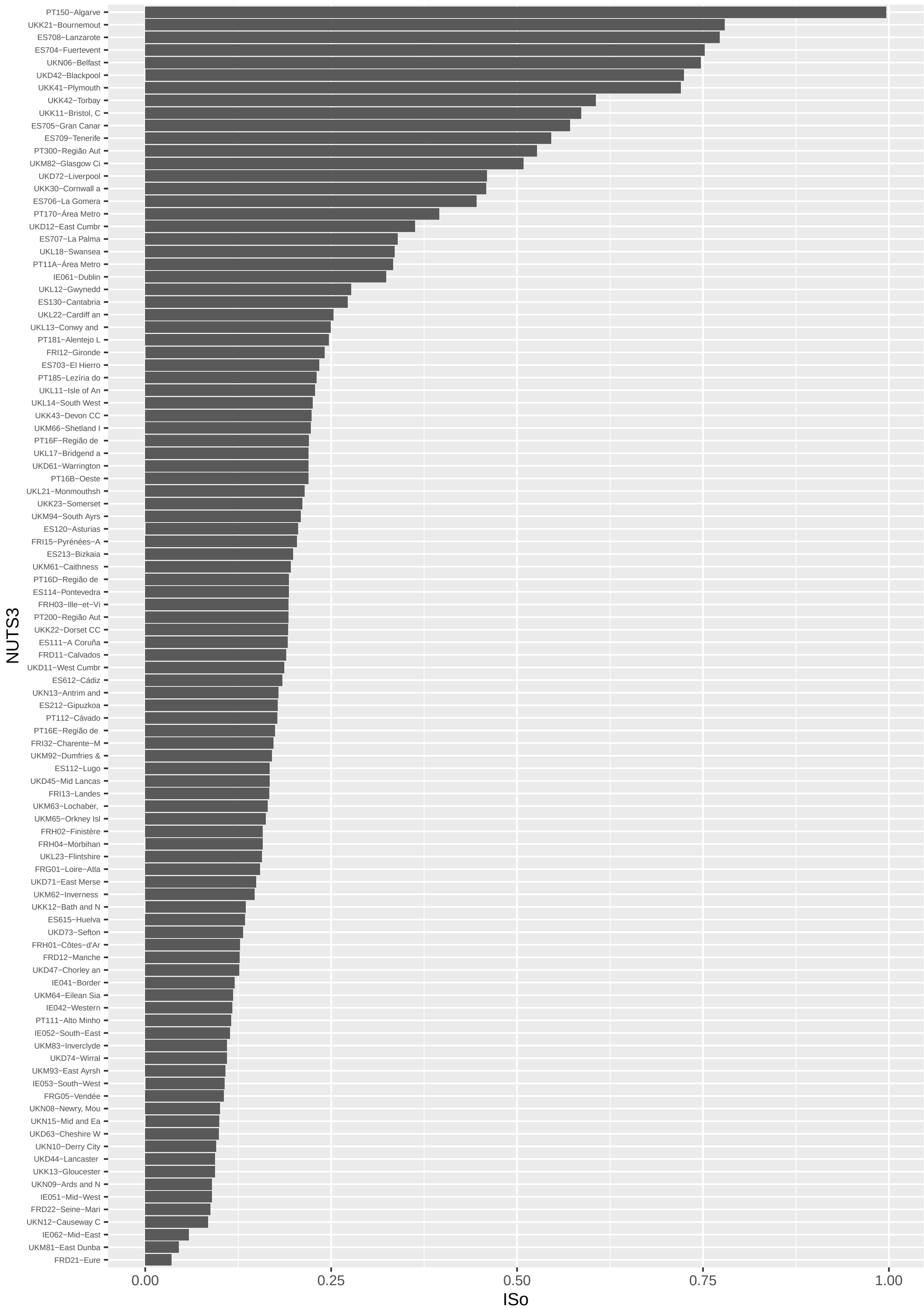


Figure B3. Vector 3 ranking: coastal activities and tourism

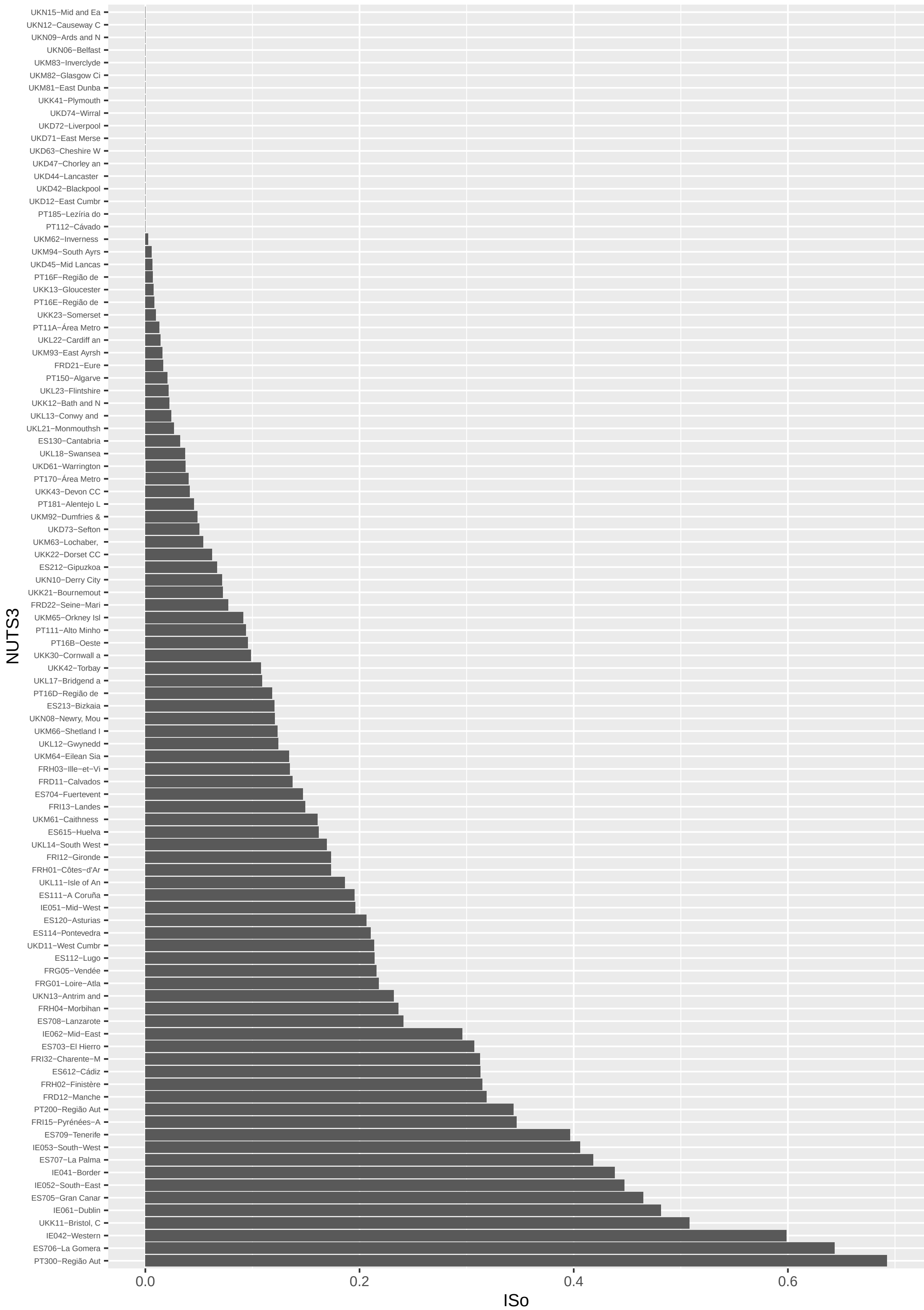


Figure B4. Vector 4 ranking: protection of coastal areas

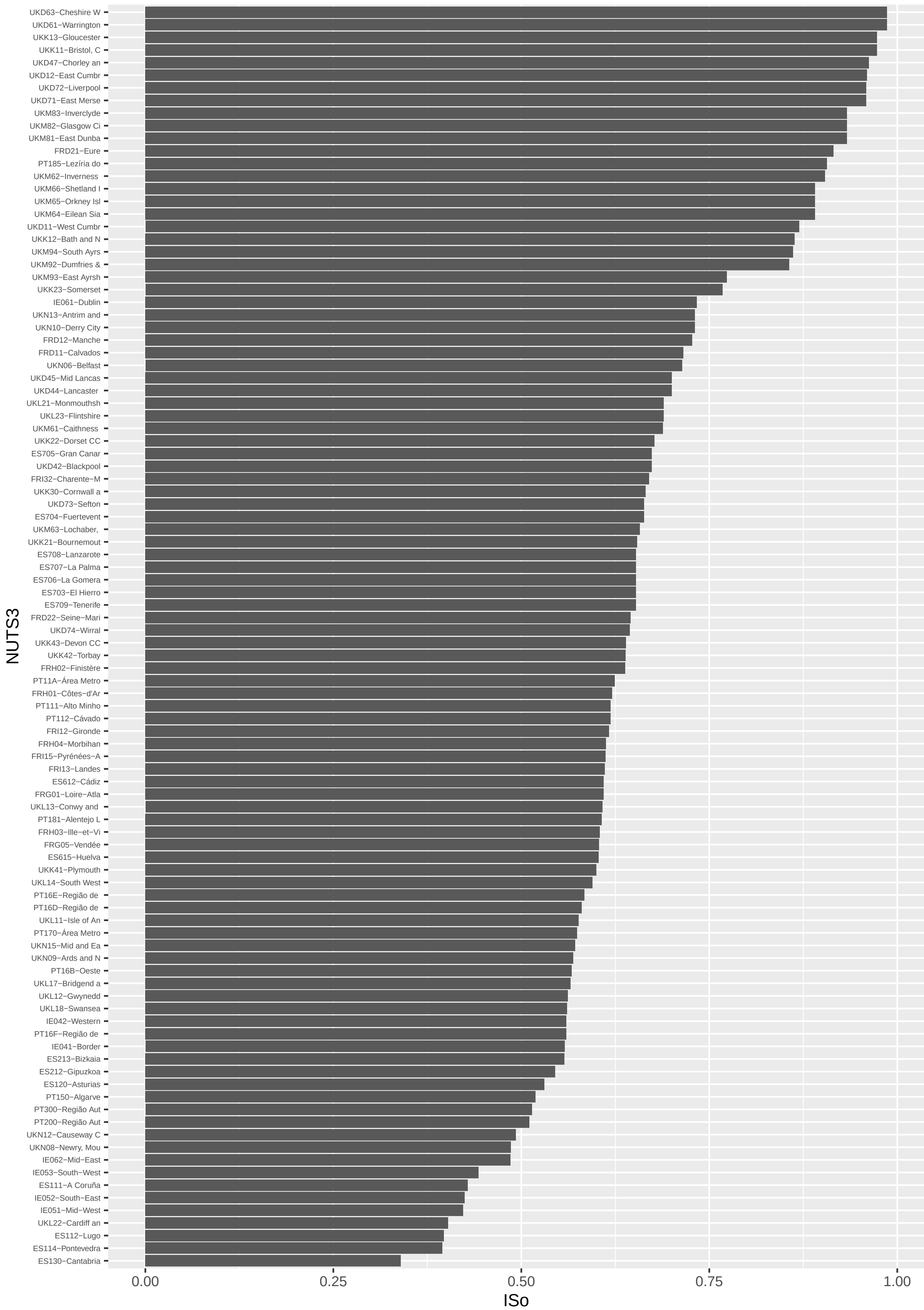


Figure B5. Vector 5 ranking: bathing water quality

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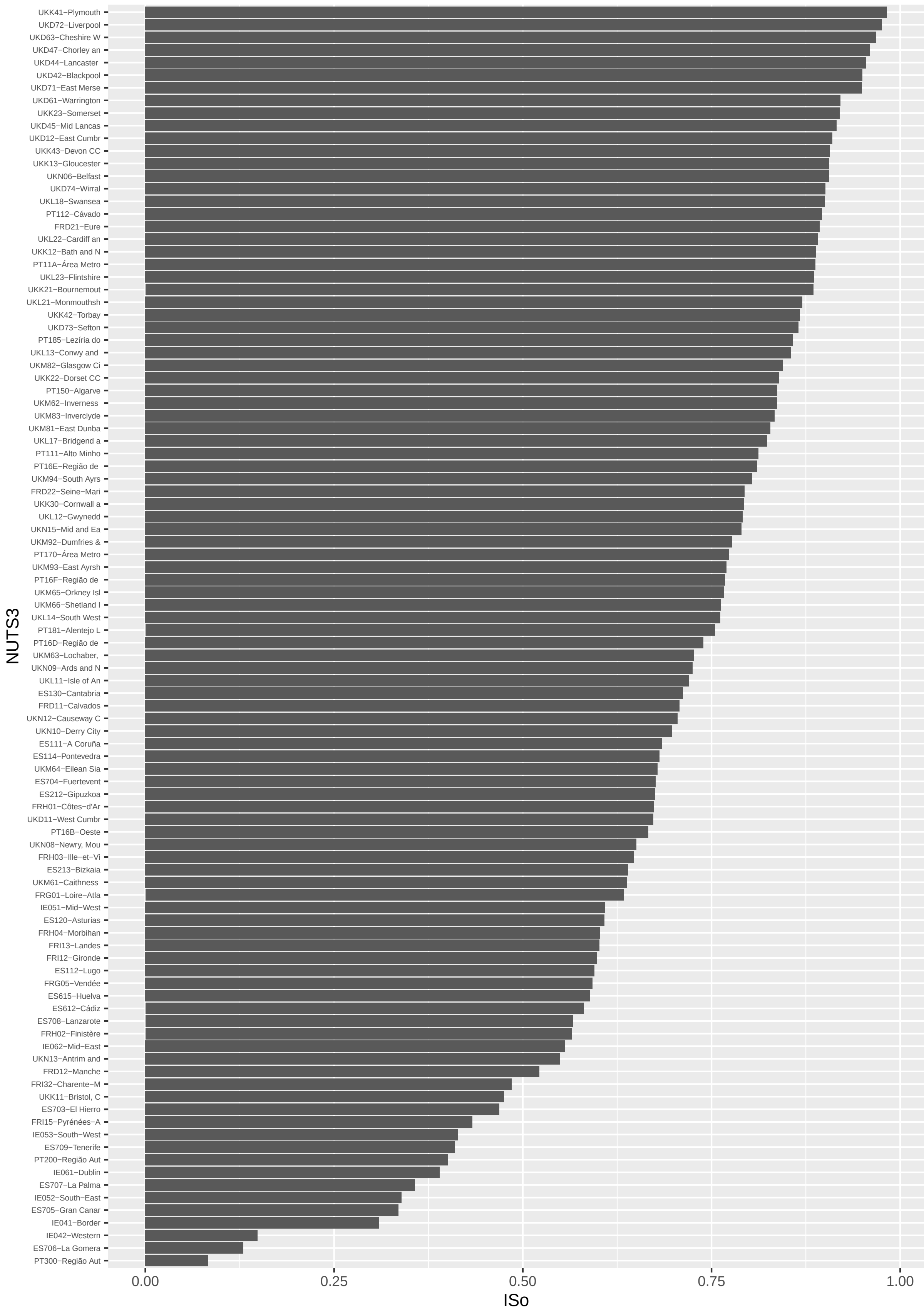

Figure B6. Overall sinthetic index ranking

Appendix C: Bar plots of NUTS3-level vulnerability Index (alphabetical)

Figure C1. Vector 1: marine spill risk

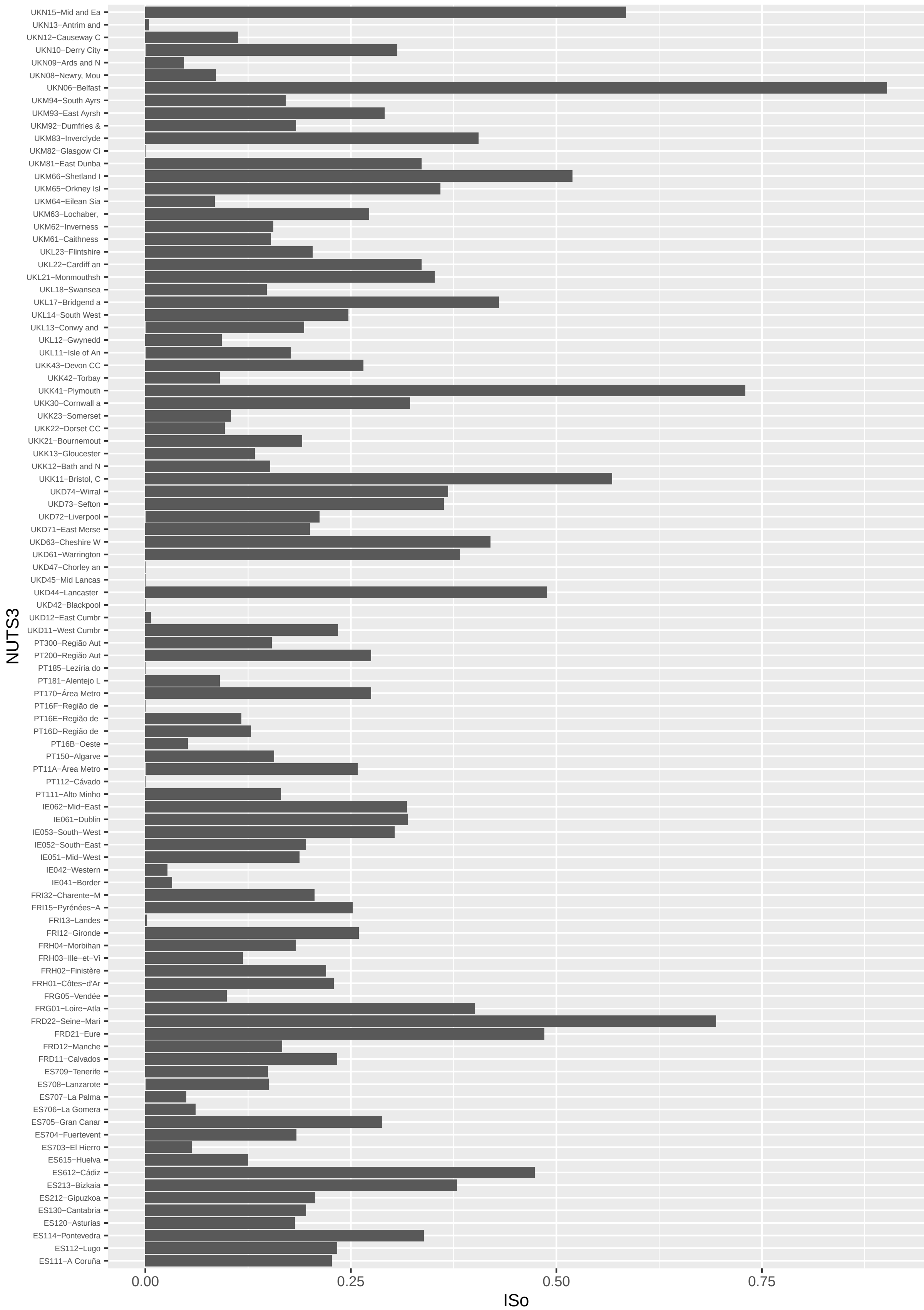

Figure C2. Vector 2: port facilities impact

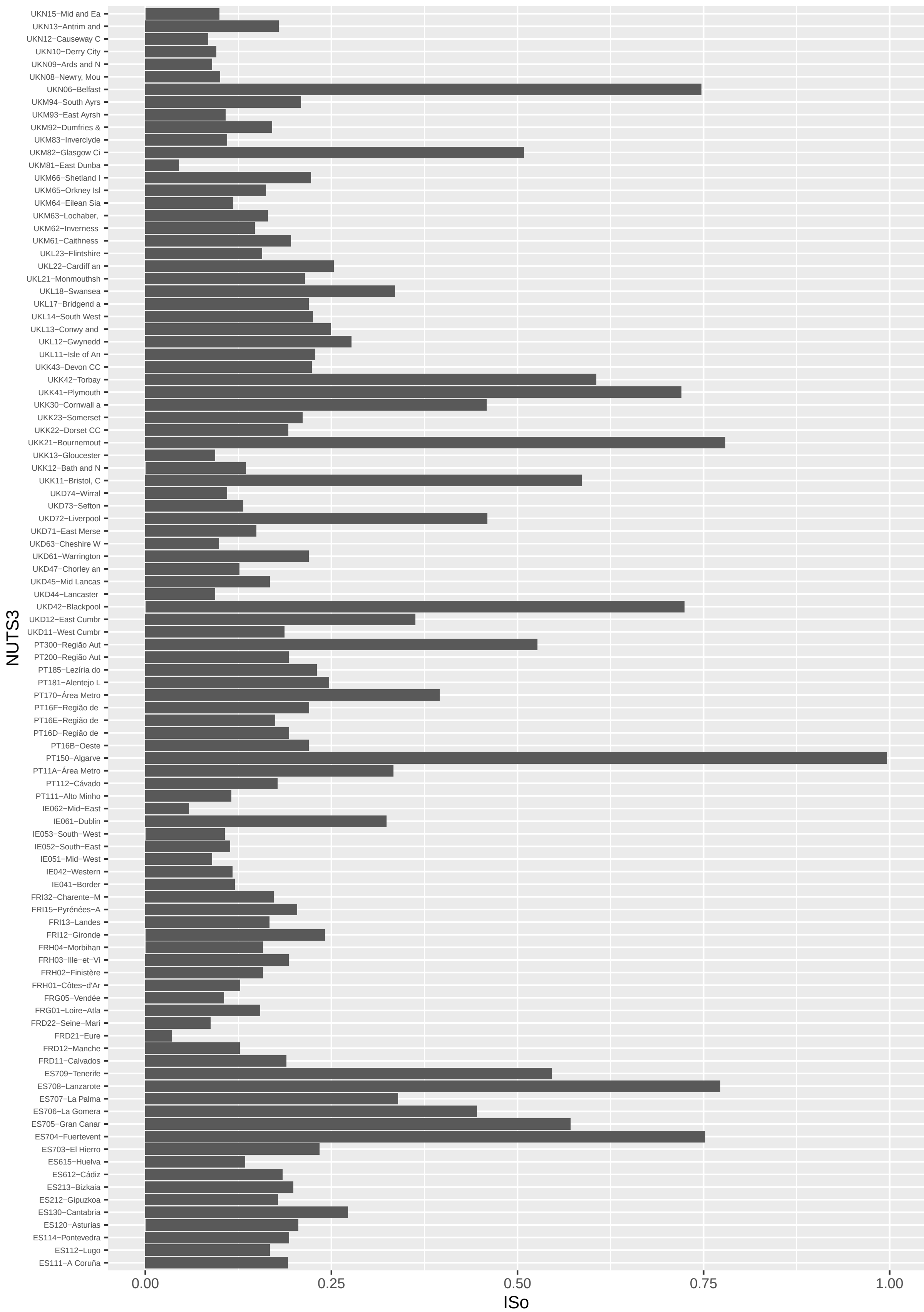

Figure C3. Vector 3: coastal activities and tourism

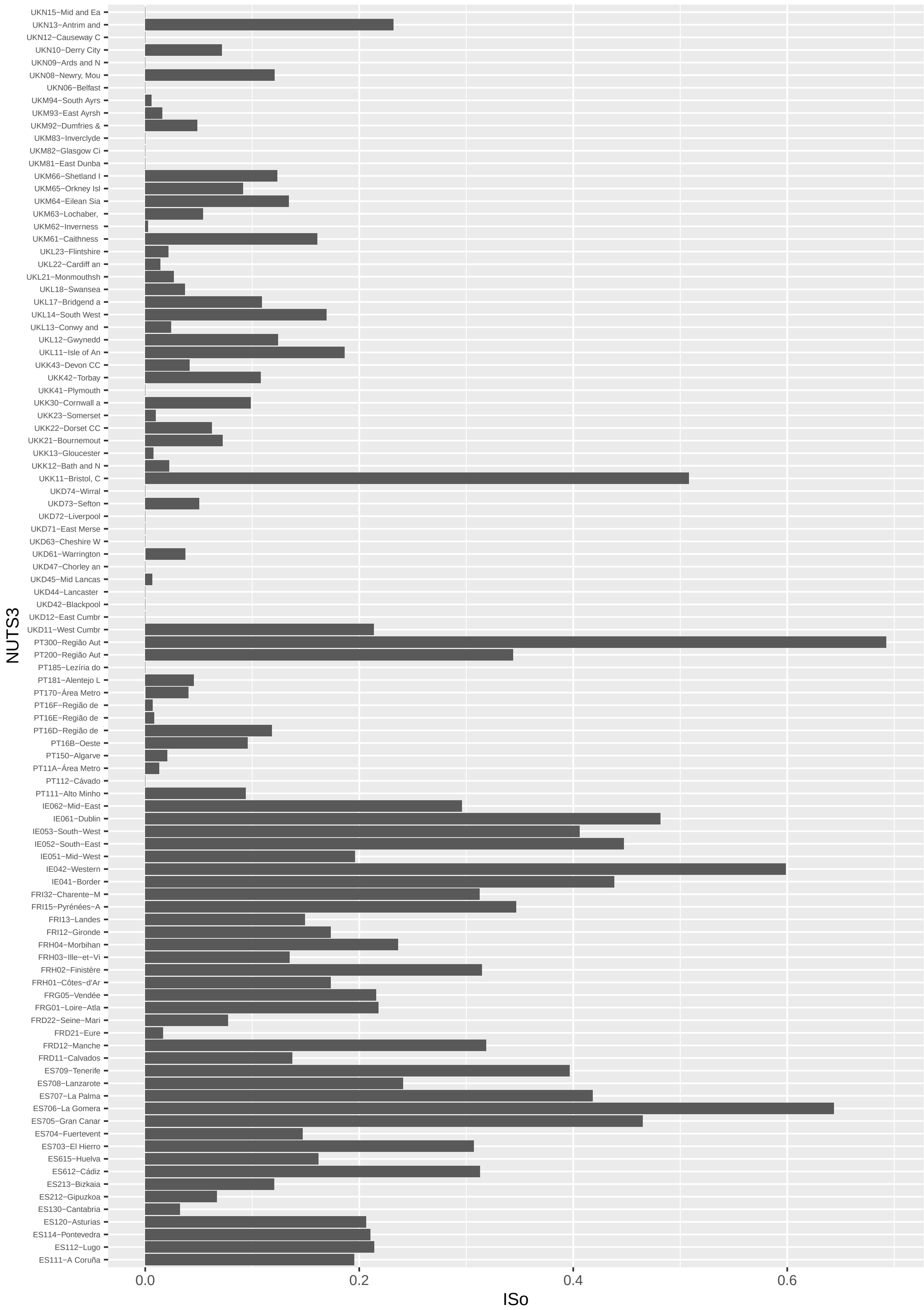

Figure C4. Vector 4: protection of coastal areas

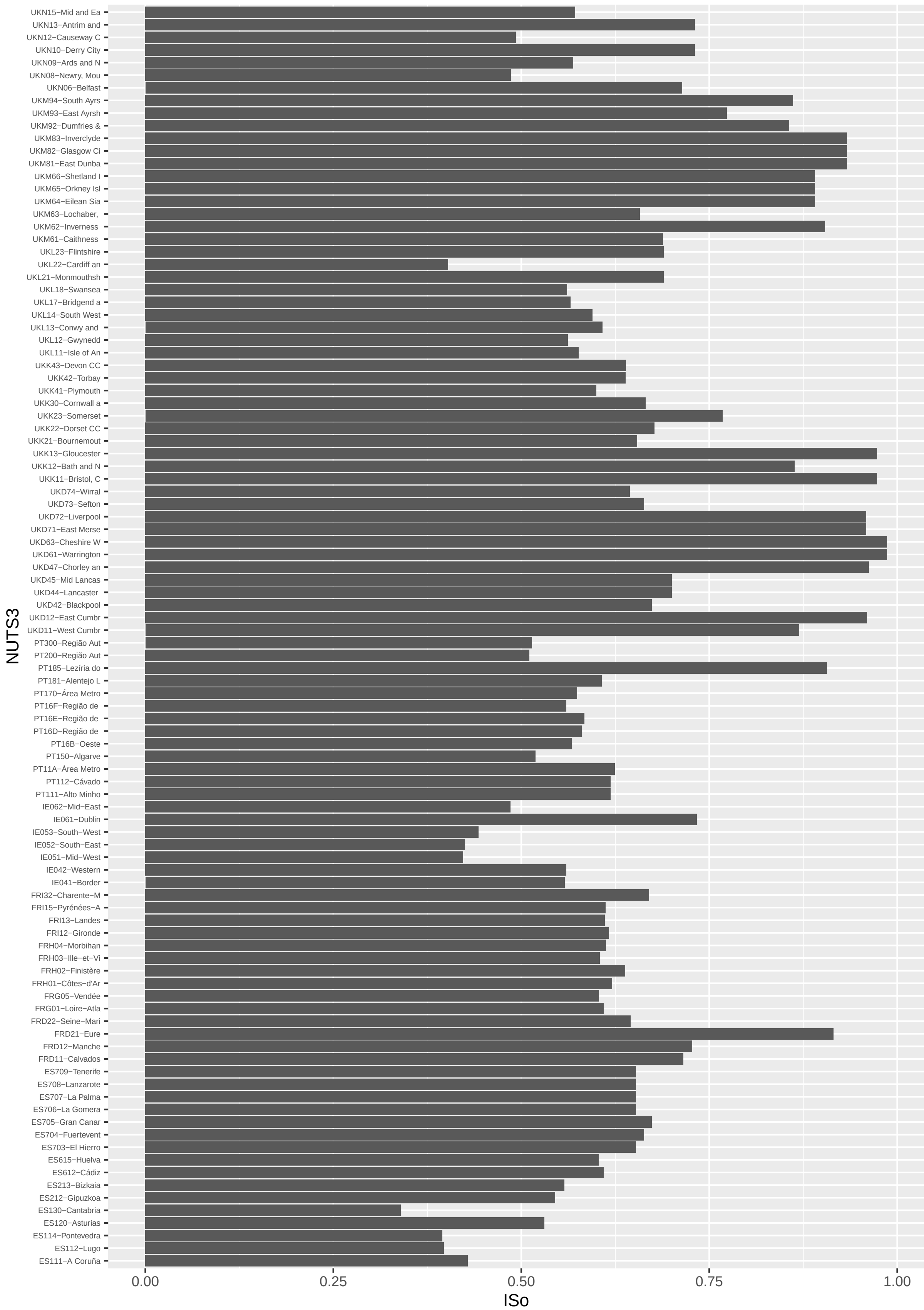

Figure C5. Vector 5: bathing water quality

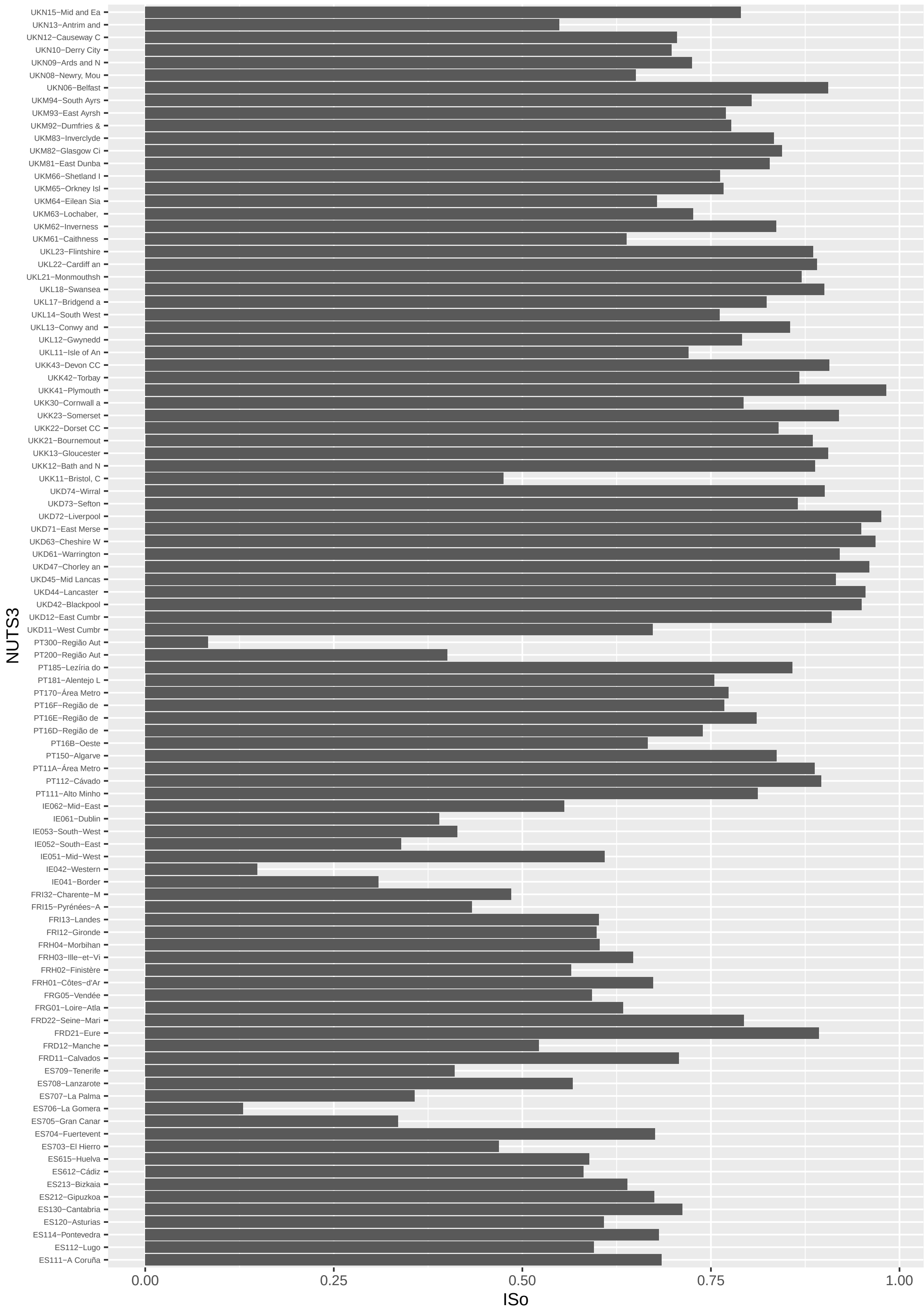

Figure C6. Overall sinthetic index

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