CINEA/EMFAF/2021/3.1.2/03/SC04/SI2.881222

Specific Contract 2021/3.1.2/03/SC04

Hosting, maintenance and further development of the Regional Database for the Mediterranean and Black Seas

Med&BS RDBFIS

tools4MCDA: input data, procedures and outcomes

Presenting: Irida Maina

R package: **tools4MCDA**

The R package is on Github: https://github.com/iridamaina/tools4MCDA

Tools for estimate fishing effort, weight and value of landings using Multi-Criteria Decision Analysis

Documentation for package ‘tools4MCDA’ version 0.1

- DESCRIPTION file.
- Package NEWS.

Help Pages

add_LPUE	Add a field related to Landings Per Unit of Effort (LPUE) in the dataframe derived based on MCDA
bubble_plot_year	Create a bubble map by year
catch_ERSIevel	Convert the estimated landings weight or value for SSF expressed in tonnes or euro using Fishing Pressure Index and Landings Per Unit of Effort as a proxy in a grid cell of 0.5*0.5 decimal degrees (csquare) in order to inform Table H.
check_FDays	Compare fishing effort in days at sea estimated using Fishing Pressure Index from MCDA as a proxy and table_G effort estimations by GSA/gear/metier/quarter/fishing_tech/target_assemblage/year/country
check_landings	Compare fishing effort in days at sea estimated using Fishing Pressure Index as a proxy with table_A landings estimations by GSA/gear/metier/quarter/fishing_tech/target_assemblage/year/country/species
classify	Classify a dataframe
create_tableH	Converts the estimated spatial landings' weight and value in the format of table H of the FDI data call
create_tableI	Converts the estimated spatial fishing effort in the format of table I of the FDI data call
ERA5NetcdfToCsv	Convert netcdf containing meteorological data from Copernicus products to a data frame and store in a csv

Development of an **r-package** to support and automate the process

Components	**General description of the functions developed** (ongoing work of **RDBFIS project**)
Spatial Fishing Pressure Index (FPI) by MCDA	Grading of a dataset (ranking procedure)
	Normalization of a data object (fuzzyfication process)
	Analytic Hierarchy Process (AHP)
	Fishing gear interpolation for estimating Activity index based on Inverse Distance Weighted
Fishing effort estimation	Compare fishing effort in days at sea estimated using Fishing Pressure Index as a proxy with effort estimations by GSA/gear/quarter/year/country (based on table G)
	Estimate fishing effort for Small Scale Fisheries (SSF) expressed in days at sea using Fishing Pressure Index as a proxy
Spatial landings by species	Estimate spatial landing weight or value using Fishing effort and landings per unit effort as a proxy
	Compare catch expressed in landing weight, landing value, discard weight estimated using Fishing Pressure Index as a proxy with table A by GSA/gear/quarter/year/country
Spatio-temporal FPI by MCDA	Convert netcdf containing meteorological data from Copernicus products to a data.frame and store in a csv.
	Create meteorological criterion
	Convert netcdf containing meteorological data (other from Copernicus) to csv.
Supplementary functions	Dataframe to RasterLayer conversion
	Combine Fishing Pressure Index (FPI- estimated by MCDA) with EEZ polygons to estimate the country
	Combine Fishing Pressure Index (FPI- estimated by MCDA) with GSA polygons to estimate the Geographical Sub-Area.
	Extract values from Fishing Pressure Index RasterLayer in a data frame with longitude, latitude
	Shapefile to RasterLayer conversion
	Plotting

Med&BS RDBFIS

Financed by EMFF (2021-2022) and CINEA/EMFAF (2023-2025)

r-package: **tools4MCDA**

Preparatory scripts

a) Extracting spatial data in a fine regular grid

b) estimate weights based on AHP

c) plot input data that will be used in the MCDA (first evaluation by the user)

Main scripts

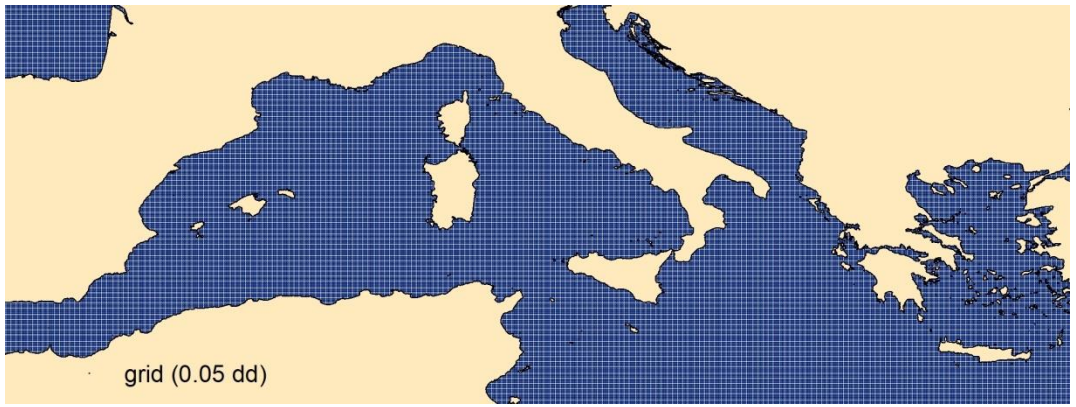
1) Estimate a proxy of fishing pressure from SSF based on MCDA

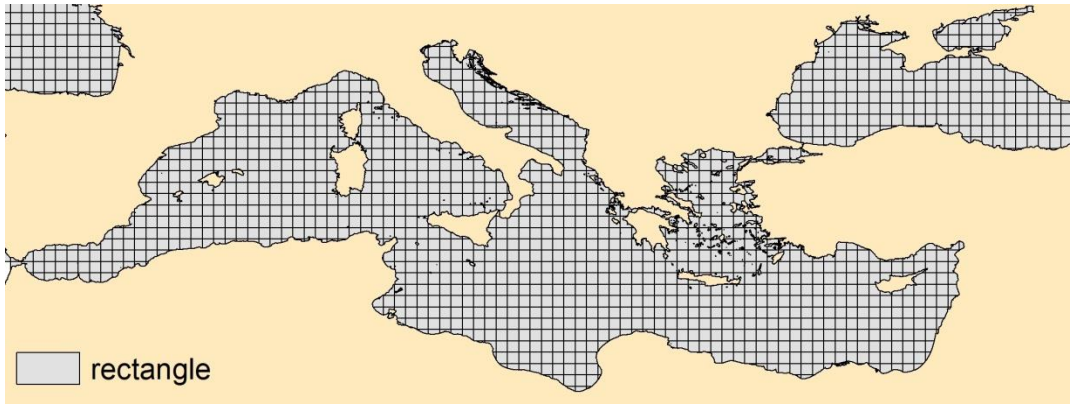
2) Estimating fishing effort, weight & value of landings in the format of tables H and I using:

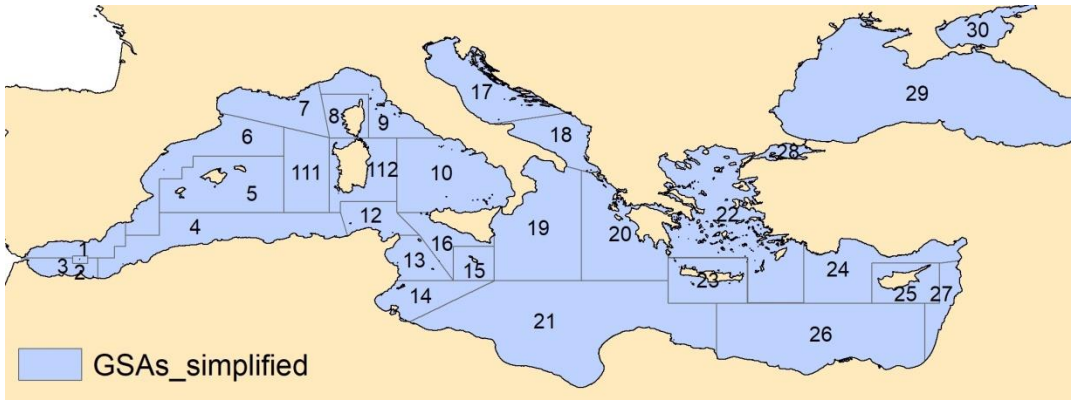
i) the proxy of fishing pressure from MCDA,
ii) tables A and G (FDI data call format)
iii) Outcomes of SDM

Input data

- A fine grid for performing the analysis (e.g. 0.05 dd)
- The grid that is used in table H and I (i.e 0.5 dd)
- Geographical Sub-areas (GSAs)
- Supplementary a polygon of EEZ can be used

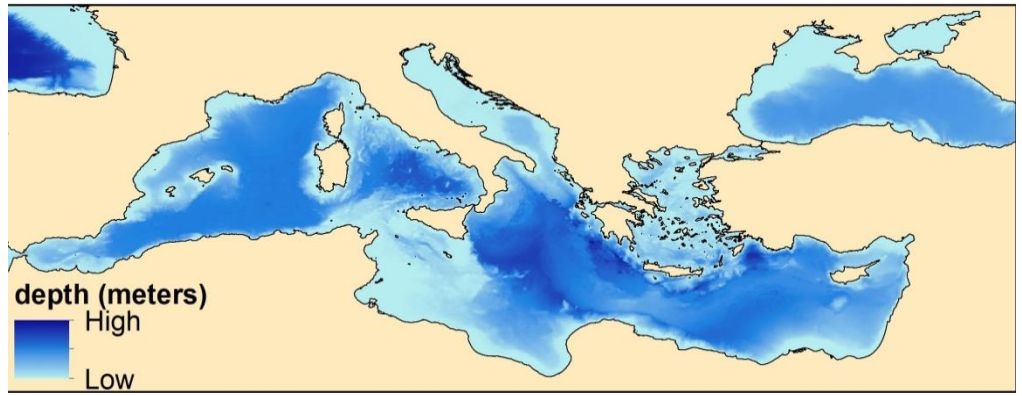


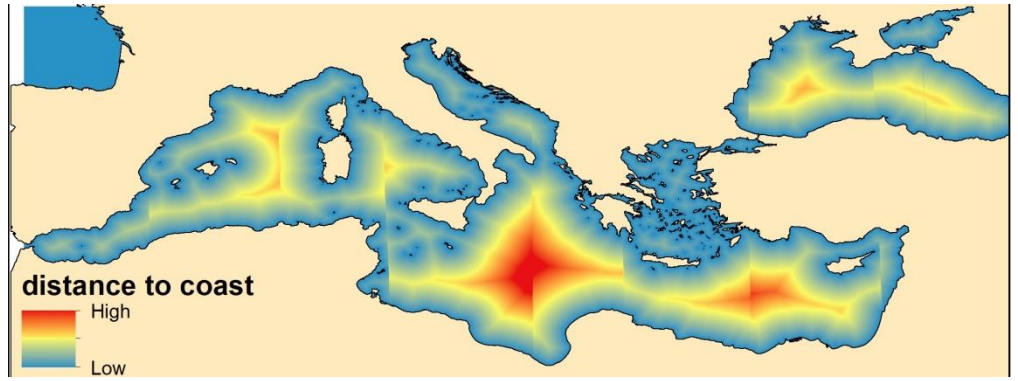


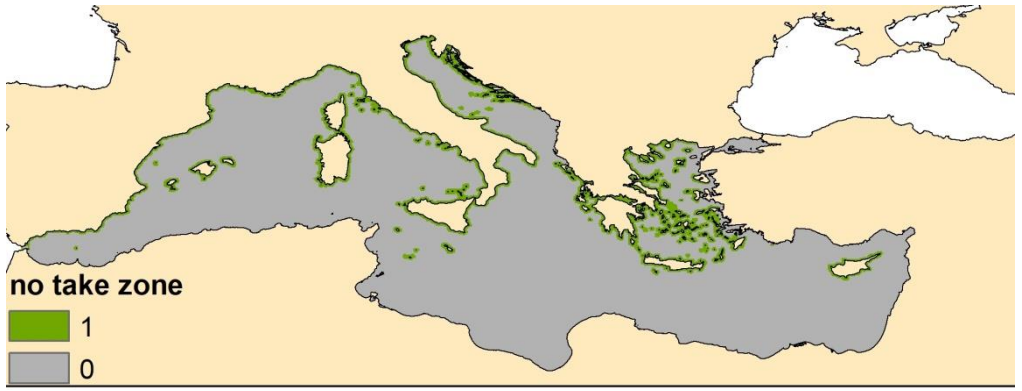


Input data

- Depth
- Distance to coast
- No take areas (due to legislation or other reasons)

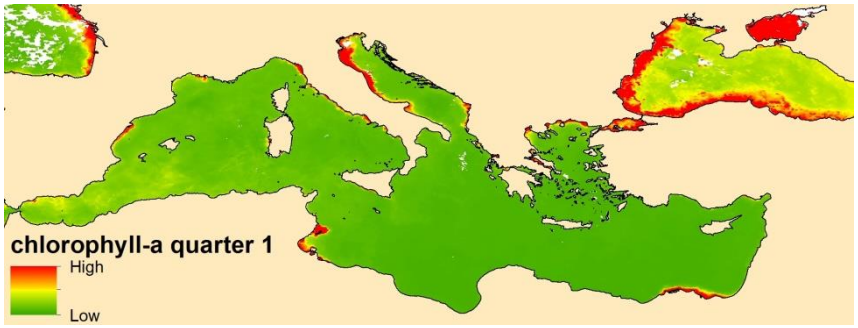


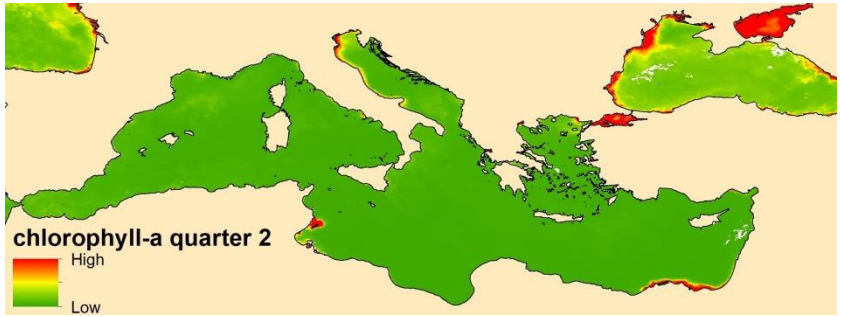


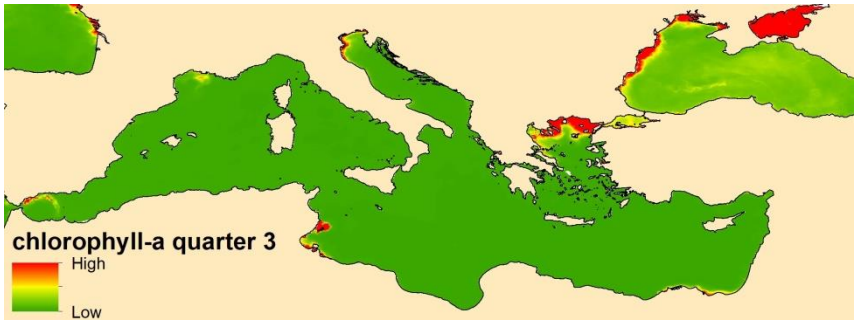


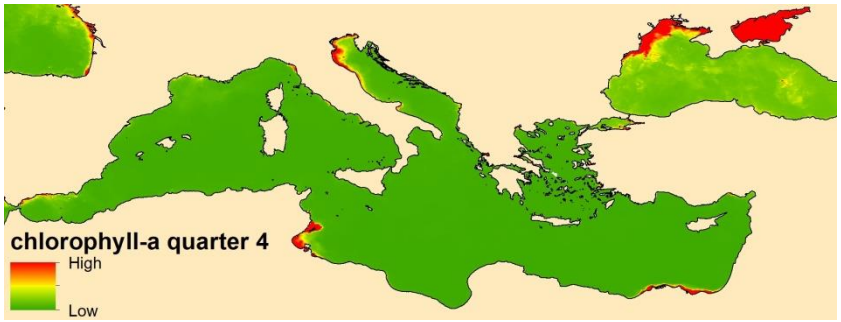
Input data

- Chlorophyll-a by quarter



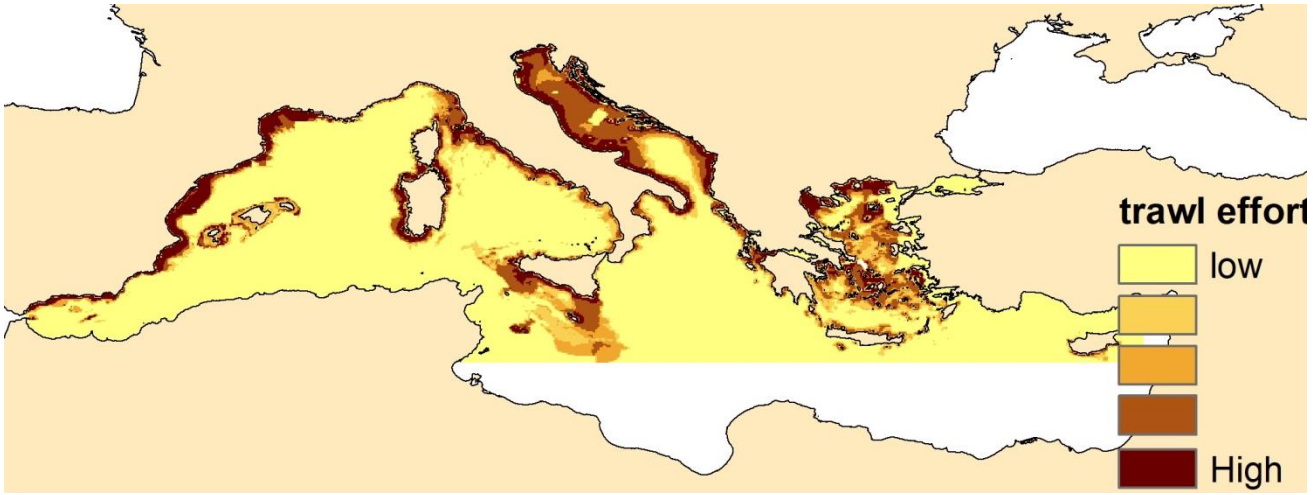


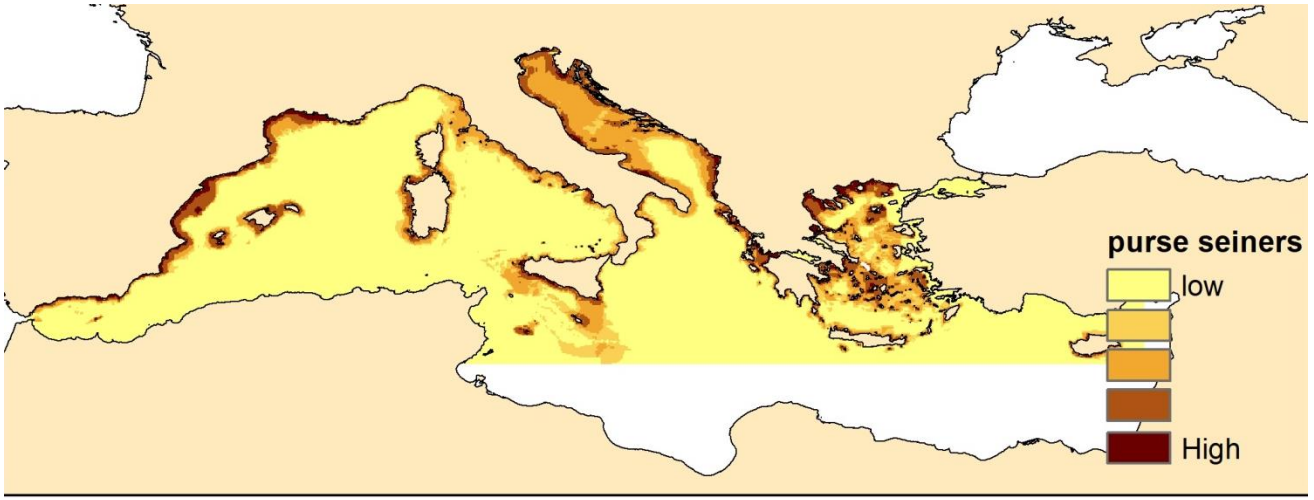




Input data

- Fishing effort from trawl by quarter
- Fishing effort from purse seiners by quarter





Input data

- Grading values per criterion, gear and vessel length category

Depth cuts	Depth grades	coastdist cuts	Coastdist grades	Chl cuts	Chl grades	Otb cuts	Otb grades	Ps cuts	Ps grades	Gear type	Vessel length
NA	0	NA	NA	NA	0	NA	5	NA	5	GNS	VL0006
0	5	0	5	0	1	0	5	0	5	GNS	VL0006
50	4	0.5	4	0.1	1	0.2	4	0.2	4	GNS	VL0006
100	3	1.5	3	0.23	2	0.4	3	0.4	3	GNS	VL0006
150	2	2.5	2	0.46	3	0.6	2	0.6	2	GNS	VL0006
200	1	3	1	0.793	4	0.8	1	0.8	1	GNS	VL0006
500	0	6	0	2	5	1	1	1	1	GNS	VL0006
NA	0	NA	NA	NA	0	NA	5	NA	5	GNS	VL0612
0	5	0	5	0	1	0	5	0	5	GNS	VL0612
50	4	0.5	4	0.1	1	0.2	4	0.2	4	GNS	VL0612
100	3	1.5	3	0.23	2	0.4	3	0.4	3	GNS	VL0612
150	2	2.5	2	0.46	3	0.6	2	0.6	2	GNS	VL0612
200	1	3	1	0.793	4	0.8	1	0.8	1	GNS	VL0612
500	0	6	0	2	5	1	1	1	1	GNS	VL0612

Input data

- Fishing fleet by registration port (in the format extracted by RDBFis)

COUNTF	YEAR	PLACE_C	FISHING	PORT_G	MAIN_F	LONGITU	LATITUD	SUM_LC	N_FVS	AVG_LO	AVG_GT	vessel_le
CYP	2005	1	Paralimr	MED	GTR	34.036	35.038	1743.8	69	8.01	2.89	VL0006
CYP	2005	10	Limasso	MED	GTR	33.016	34.651	4699.5	157	8.05	3.31	VL0006
CYP	2005	11	Paphos	MED	GTR	32.407	34.754	1847	70	7.9	2.94	VL0006
CYP	2005	12	Latsi	MED	GTR	32.395	35.041	674.46	28	7.8	2.88	VL0006
CYP	2005	13	Ayios Ge	MED	GTR	32.318	34.903	1211.5	36	8.46	3.59	VL0006
CYP	2005	14	Pomos	MED	GTR	32.555	35.175	356.85	15	7.81	2.75	VL0006

Input data

➢ Table G

country	year	quarter	vessel_len	fishing_tec	gear_type	target_ass	mesh_size_	metier	metier_7	supra_regi	sub_regior	eez_indica	geo_indica	specon_te
GRC	2013	1	VL1824	DTS	OTB	DEF	40D50	OTB_DEF_	NA	MBS	GSA23	NA	NK	NK
GRC	2013	1	VL1824	DTS	OTB	DEF	40D50	OTB_DEF_	NA	MBS	GSA20	NA	NK	NK
GRC	2013	4	VL1218	DTS	OTB	DEF	40D50	OTB_DEF_	NA	MBS	GSA22	NA	NK	NK
GRC	2013	3	VL1218	DTS	OTB	DEF	40D50	OTB_DEF_	NA	MBS	GSA22	NA	NK	NK

deep	totseadays	totkwdays	totgtdaysa	totfishday:	totkwfishd	totgtfishda	hrsea	kwhrsea	gthrsea	totves	confidentia
NA	129	23937	5367	129	23937	5367				2	N
NA	1082	287406	53591	1082	287406	53591				20	N
NA	160	33289	5036	160	33289	5036				6	N
NA	4	632	112	4	632	112				6	N

➢ Table A

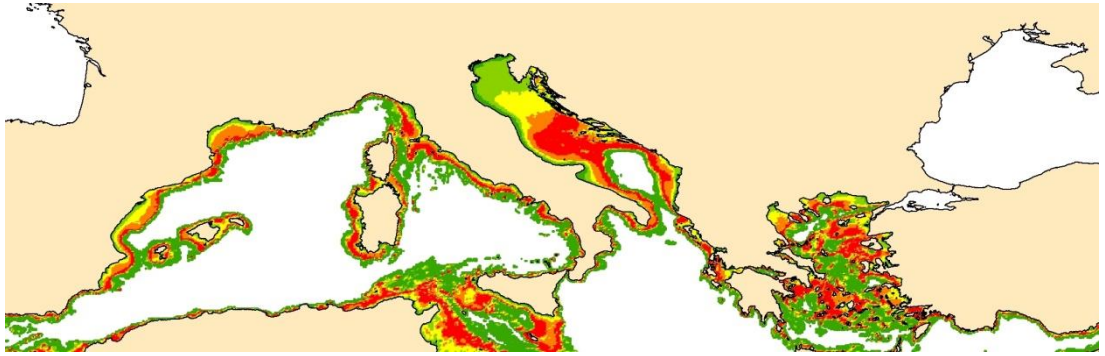
country	year	quarter	vessel_len	fishing_tec	gear_type	target_ass	mesh_size_	metier	metier_7	domain_di	domain_la	supra_regi	sub_regior
GRC	2013	4	VL0006	DFN	GNS	DEF	NK	NK	NA	NA	NA	MBS	GSA20
GRC	2013	4	VL0006	DFN	GNS	DEF	NK	NK	NA	NA	NA	MBS	GSA20
GRC	2013	4	VL0006	DFN	GNS	DEF	NK	NK	NA	NA	NA	MBS	GSA20
GRC	2013	4	VL0006	DFN	GNS	DEF	NK	NK	NA	NA	NA	MBS	GSA20

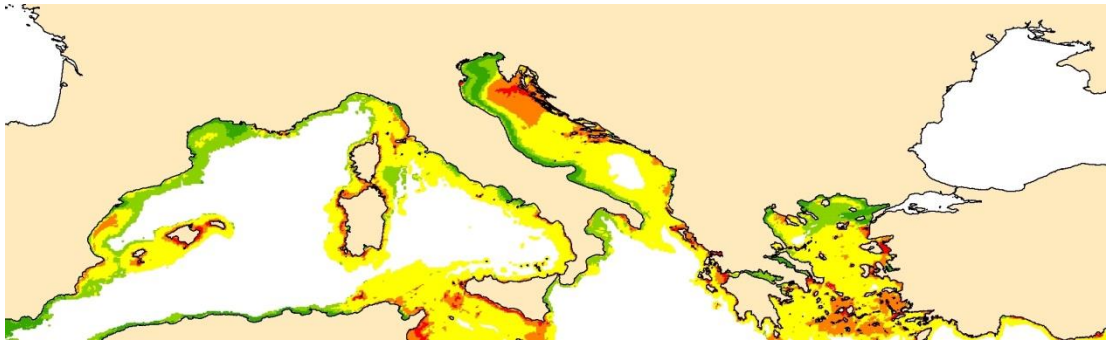
eez_indica	geo_indica	nep_sub_r	specon_te	deep	species	totwghtlar	totvalland	discards	confidentia
NA	NK	NA	NK	NA	BOG	2.978	12165	0	N
NA	NK	NA	NK	NA	BON	4.906	38286	0	N
NA	NK	NA	NK	NA	BPI	0.02	82	0	N
NA	NK	NA	NK	NA	BSS	0.903	12481	0	N

Input data

Outcomes from species distribution modeling examples for :

- HKE
- MUT



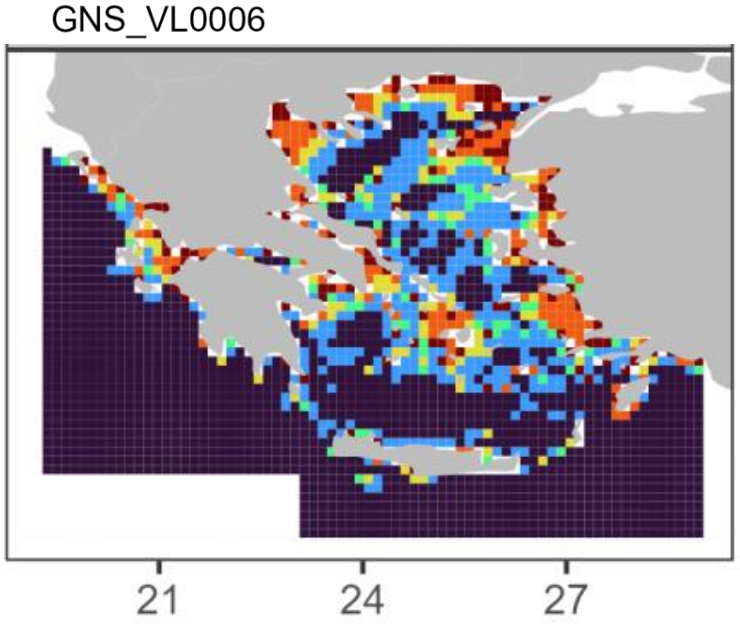


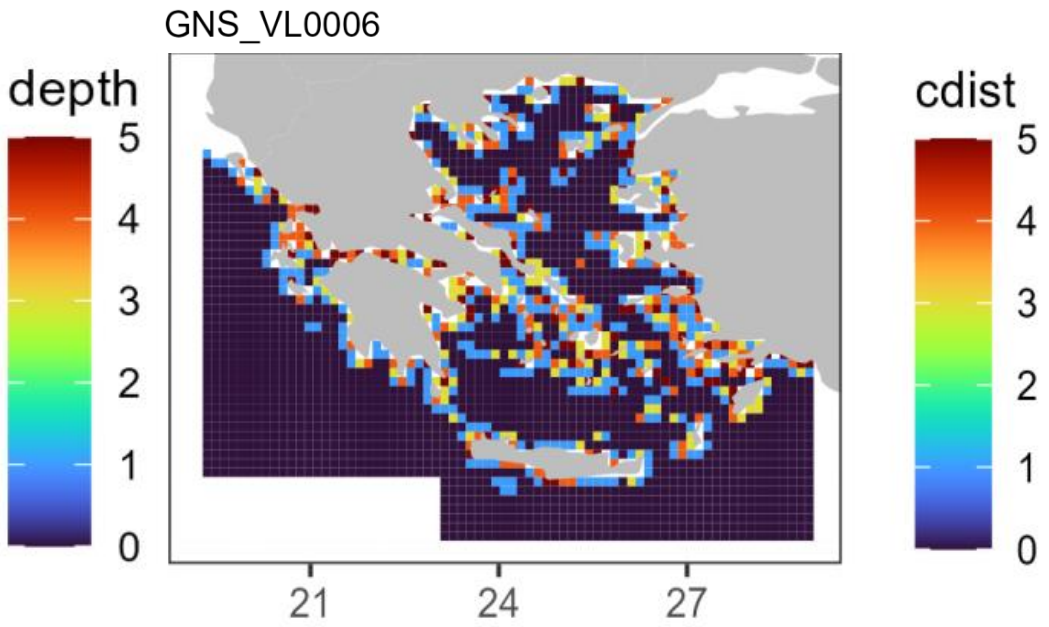
Outcomes from preparatory scripts
(b) estimate weights based on AHP

w_C_1	w_C_2	w_C_3	w_C_4	w_C_5	gear_type	vessel_len
0.401117	0.321993	0.128188	0.091716	0.056985	GNS	VL0006
0.401117	0.321993	0.128188	0.091716	0.056985	GTR	VL0006
0.401117	0.321993	0.128188	0.091716	0.056985	LLS	VL0006
0.401117	0.321993	0.128188	0.091716	0.056985	GNS	VL0612
0.401117	0.321993	0.128188	0.091716	0.056985	GTR	VL0612
0.401117	0.321993	0.128188	0.091716	0.056985	LLS	VL0612

Outcomes from preparatory scripts

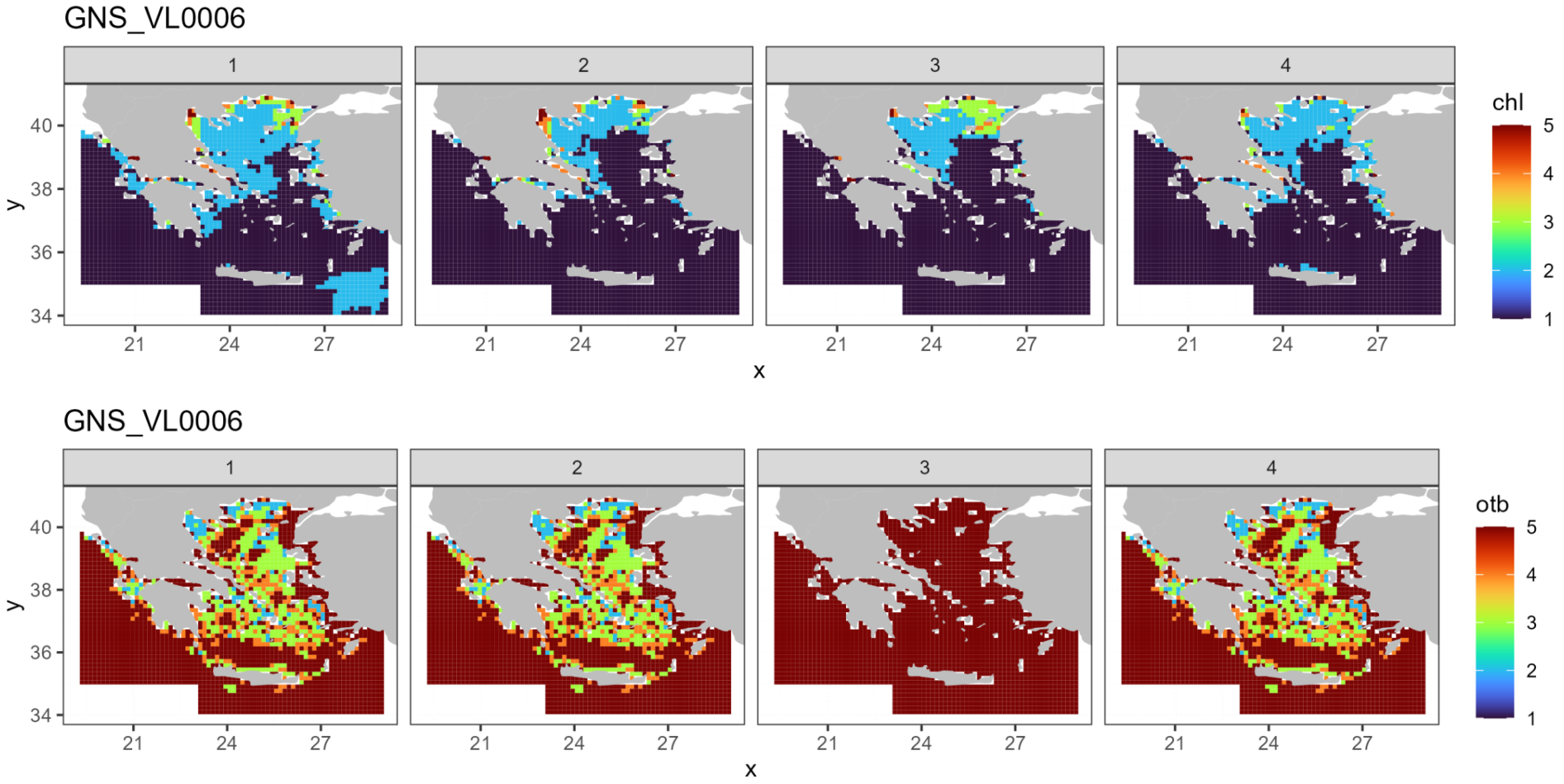
c) plot input data that will be used in the MCDA (first evaluation by the user)





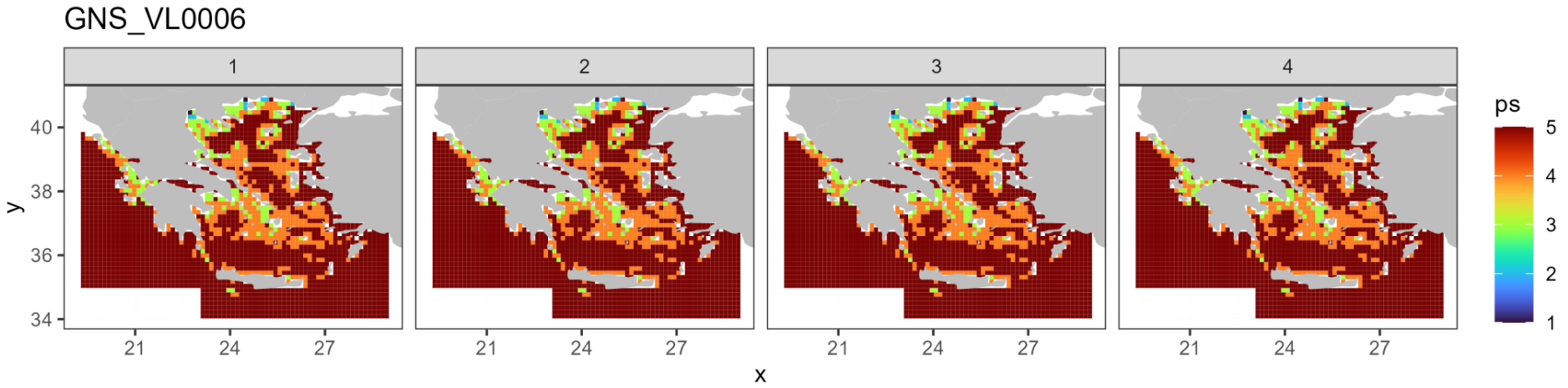
Outcomes from preparatory scripts

c) plot input data that will be used in the MCDA (first evaluation by the user)



Outcomes from preparatory scripts

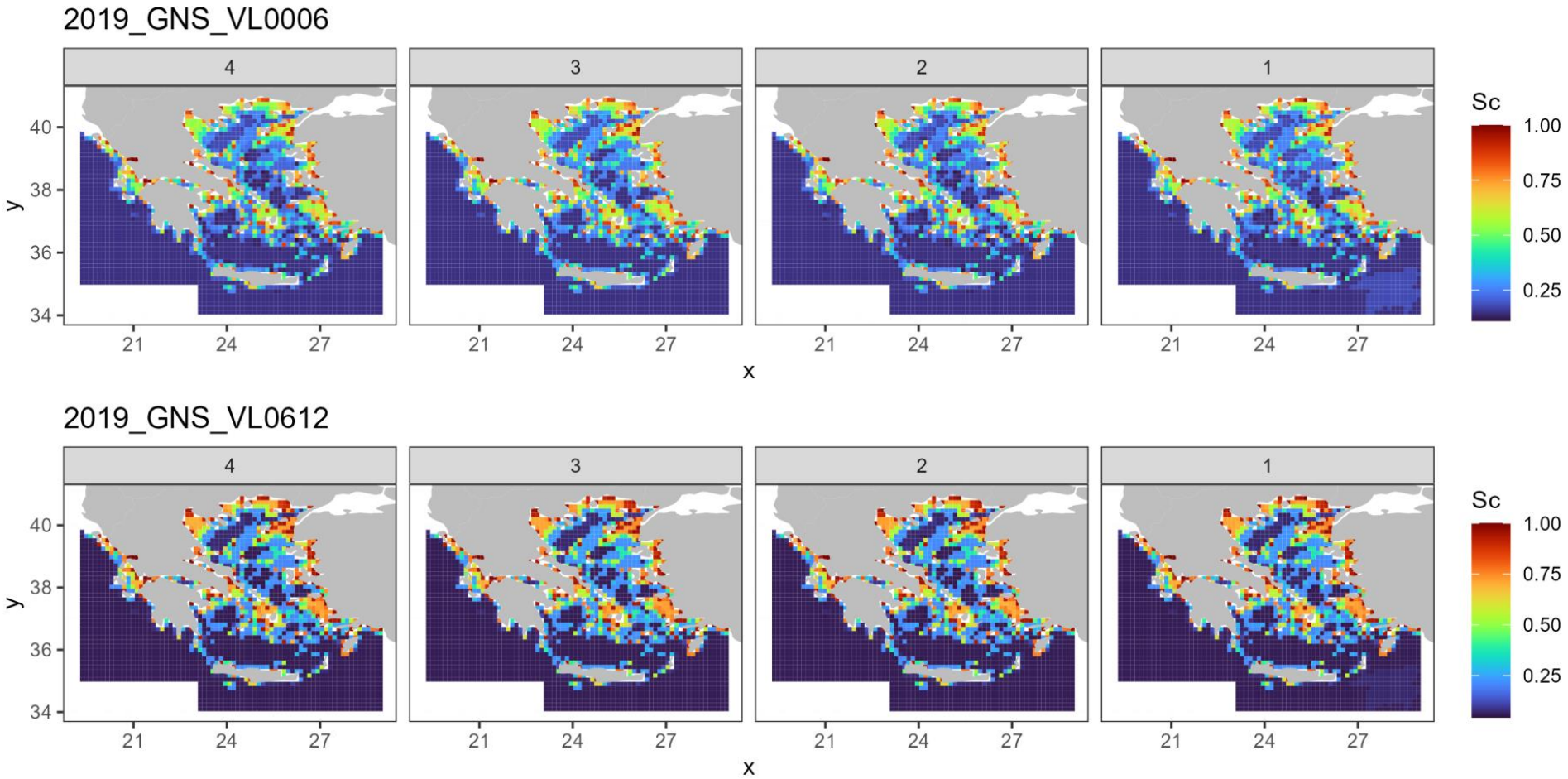
c) plot input data that will be used in the MCDA (first evaluation by the user)



Outcomes from preparatory scripts

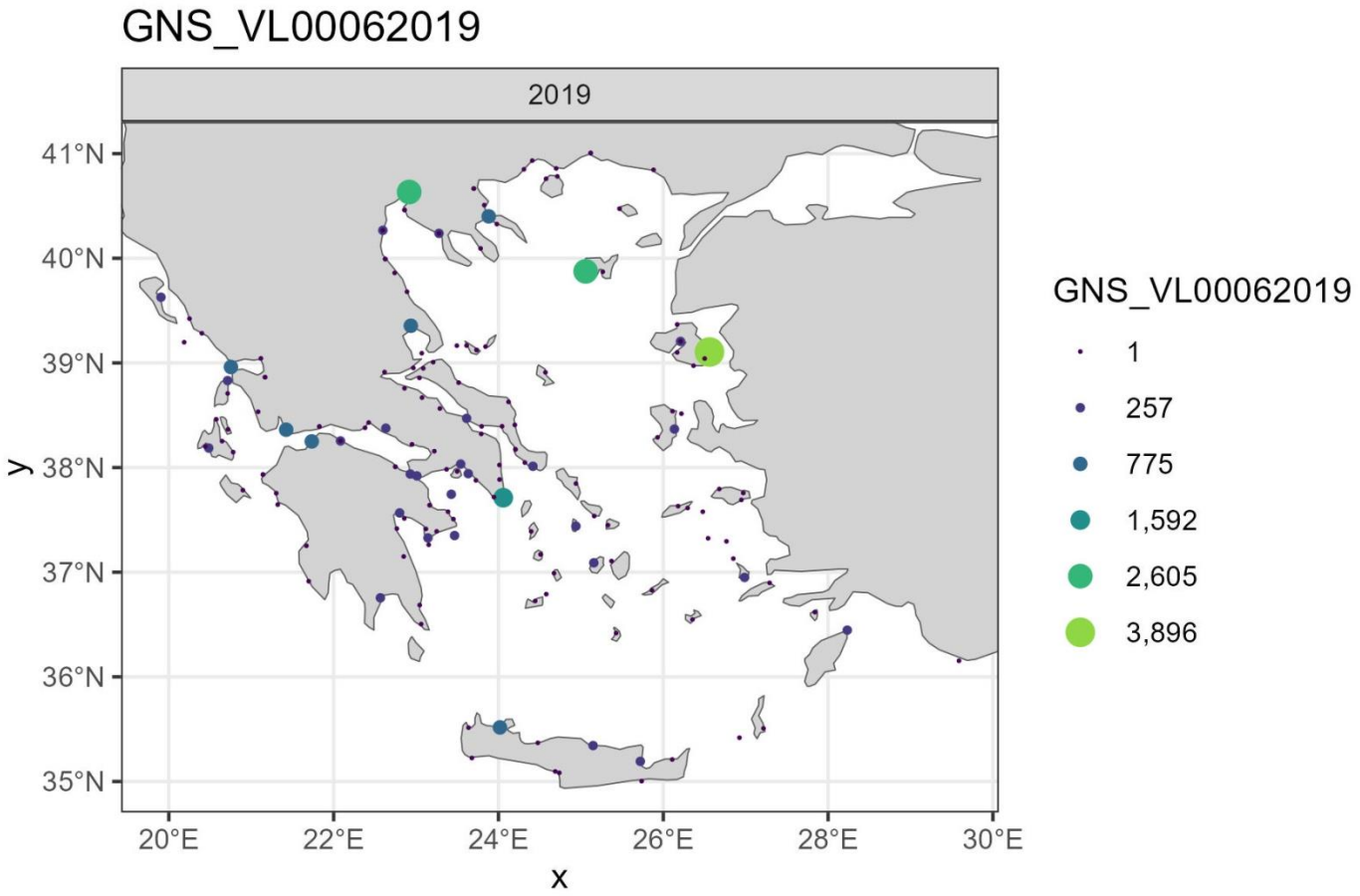
c) plot input data that will be used in the MCDA (first evaluation by the user)

- Outcomes of Sc (based on MCDA)



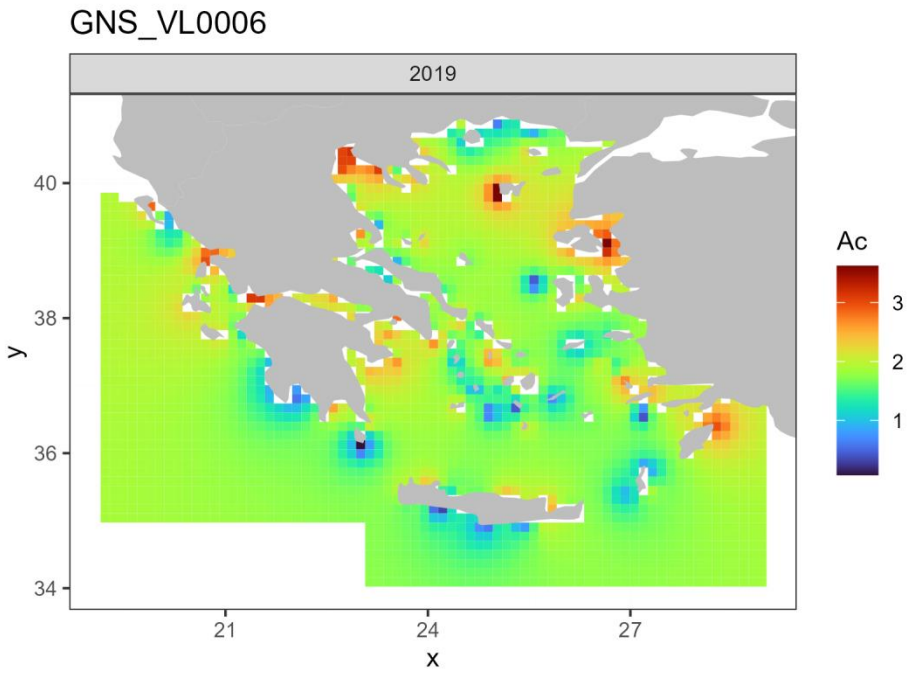
Outcomes from preparatory scripts
c) plot input data that will be used in the MCDA (first evaluation by the user)

- Plotting the index of activity (LxGT) by fishing fleet and registration port

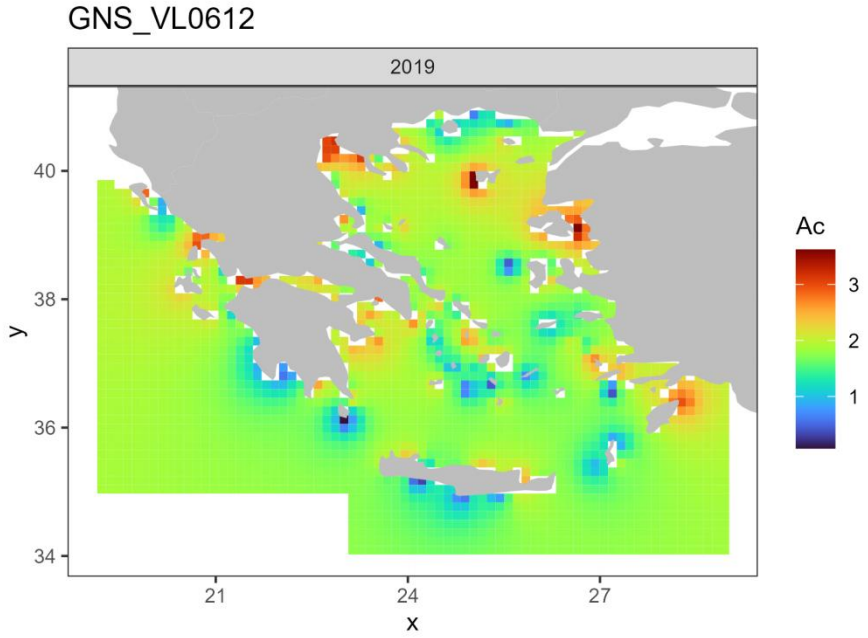


Outcomes from the preparatory scripts

c) plot input data that will be used in the MCDA (first evaluation by the user)



- Outcomes of Ac (based on interpolation)



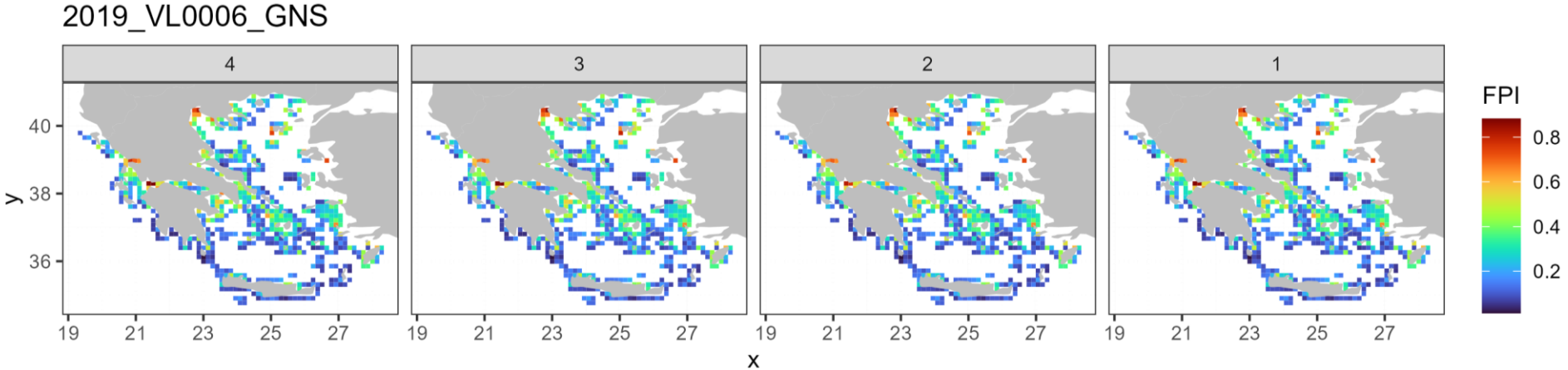
Outcomes from the main scripts

1) Perform MCDA to estimate a proxy of fishing pressure

- Proxy of fishing pressure by gear type, vessel length, year, quarter

x	y	year	quarter	FPI	gear_type	vessel_len	LON	LAT
25.025	40.975	2019	4	0.210359	GNS	VL0006	25.025	40.975
25.075	40.975	2019	4	0.320682	GNS	VL0006	25.075	40.975
25.125	40.975	2019	4	0.349548	GNS	VL0006	25.125	40.975
24.425	40.925	2019	4	0.517712	GNS	VL0006	24.425	40.925
24.475	40.925	2019	4	0.440982	GNS	VL0006	24.475	40.925
24.525	40.925	2019	4	0.393448	GNS	VL0006	24.525	40.925

- Example plots of the proxy of fishing pressure (FPI)



Outcomes from the main scripts

2) Estimating fishing effort, weight & value of landings

- Table I (spatial effort)

count	year	quart	vesse	fishin	gear_	targe	mesh_	metie	metie	supra	sub_r	eez_i	geo_i	speco	deep	rectai	latitu	longit	c_squ
GRC	2019	1	VL00(	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	2	VL00(	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	4	VL00(	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	1	VL06:	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	2	VL06:	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	3	VL06:	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	4	VL06:	DFN	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA
GRC	2019	1	VL00(	PG	GNS	DEF	NK	GNS_	NK	MBS	GSA2	NA	NK	NK	NA	05*05	34.8	23.8	NA

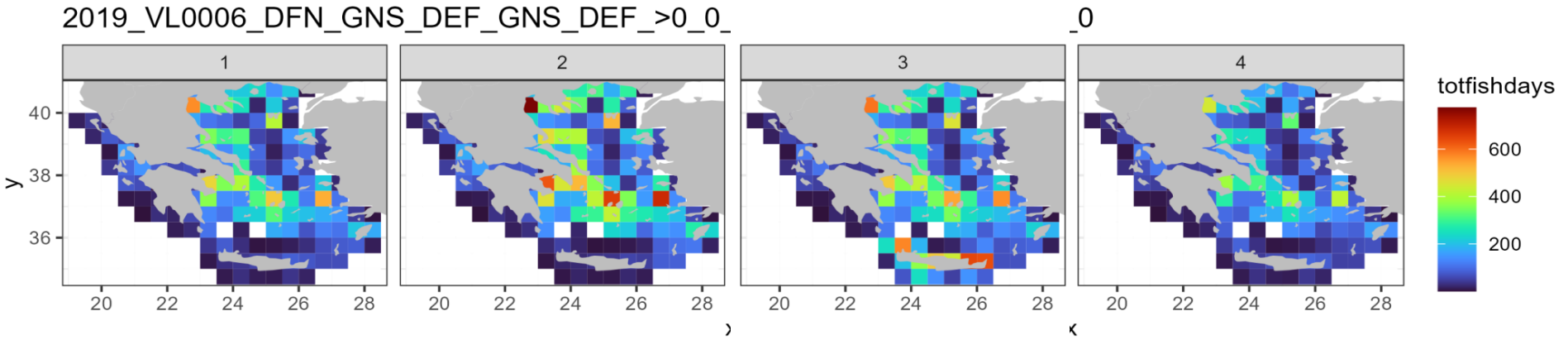
- Check difference between values estimated in table I and table G

joinFDI	FE (G)	FE (I)	check
GRC_2019_1_VL0006_DFN_GNS_DEF_GNS_DEF_>0_0_0_GSA20	1261	1261	0
GRC_2019_1_VL0006_DFN_GNS_DEF_GNS_DEF_>0_0_0_GSA22	15105	15105	0
GRC_2019_1_VL0006_DFN_GNS_DEF_GNS_DEF_>0_0_0_GSA23	656	656	0
GRC_2019_1_VL0006_DFN_GTR_DEF_GTR_DEF_>0_0_0_GSA20	23769	23769	0

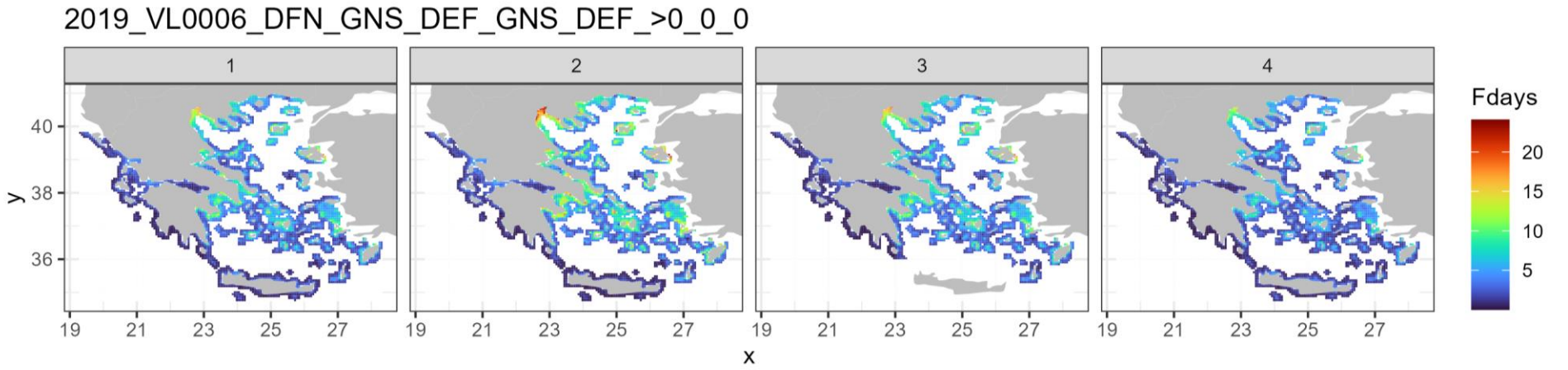
Outcomes from the main scripts

2) Estimating fishing effort, weight & value of landings

- Example plot of table I (spatial effort)



- Example plot of fishing effort in a fine grid



Outcomes from the main scripts

2) Estimating fishing effort, weight & value of landings

- Table H (spatial landings weight and value)

coun	year	quart	vesse	fishir	gear_	targe	mesh	metie	metie	supra	sub_r	eez_i	geo_	spec(	deep	recta	latitu	longi	c_sq
GRC	2019	2	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA
GRC	2019	4	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA
GRC	2019	2	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA
GRC	2019	4	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA

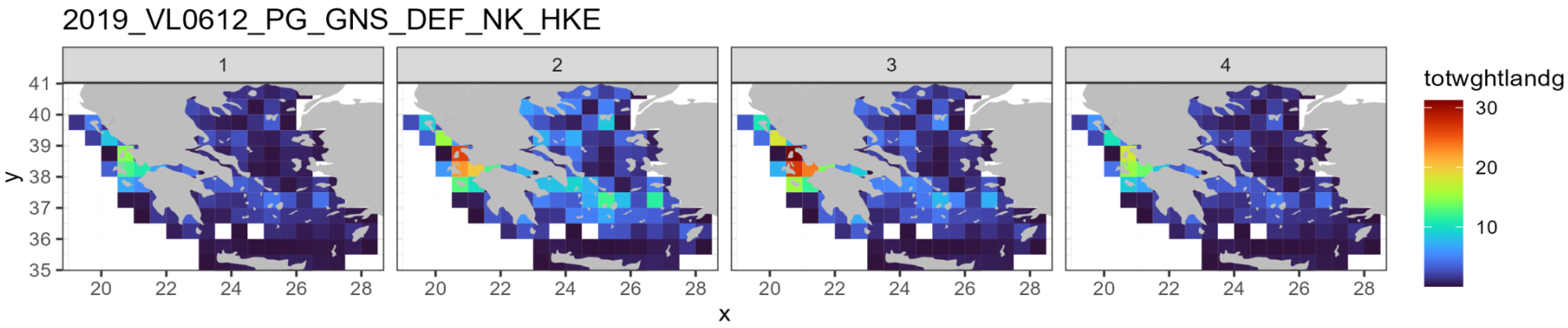
- Check difference between values estimated in table H and table A for the weight of landings

joinFDI	Weight (A)	Weight (H)	check
GSA20_GRC_GNS_2019_VL0612_HKE_1_PG_NK_DEF	104.361	104.361	0
GSA20_GRC_GNS_2019_VL0612_HKE_2_PG_NK_DEF	190.572	190.572	0
GSA20_GRC_GNS_2019_VL0612_HKE_3_PG_NK_DEF	225.091	225.091	-2.84E-14
GSA20_GRC_GNS_2019_VL0612_HKE_4_PG_NK_DEF	129.372	129.372	0

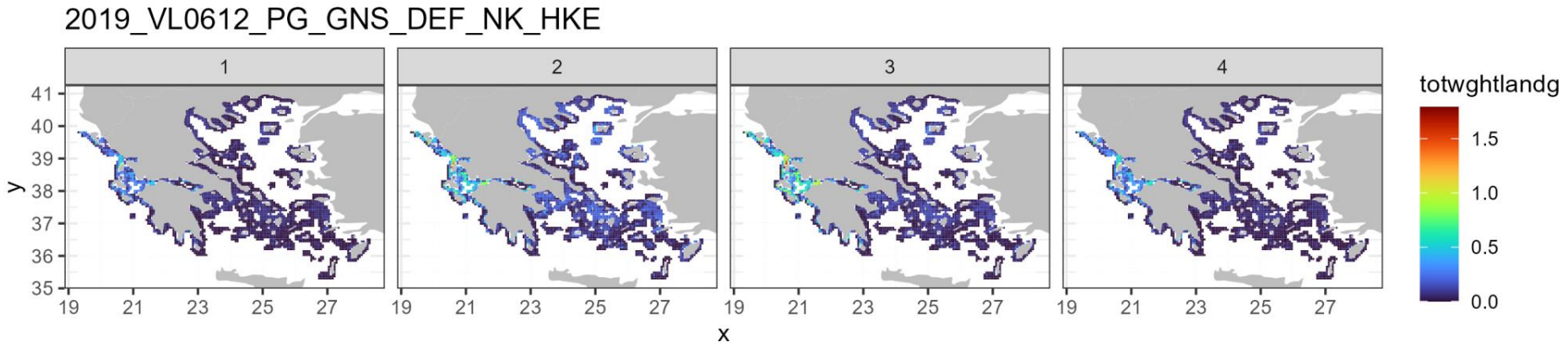
Outcomes from the main scripts

2) Estimating fishing effort, weight & value of landings

- Example plot of table H (spatial landings weight)



- Example plot of landing weight in a fine grid



Outcomes from the main scripts

2) Estimating fishing effort, weight & value of landings

- Table H (spatial landings weight and value)

coun	year	quart	vesse	fishin	gear_	targe	mesh	metie	metie	supra	sub_r	eez_i	geo_	spec(	deep	recta	latitu	longi	c_sq
GRC	2019	2	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA
GRC	2019	4	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA
GRC	2019	2	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA
GRC	2019	4	VL06	PG	GTR	DEF	NK	NK	NK	MBS	GSA2	NA	NK	NK	NA	05*0	35	24	NA

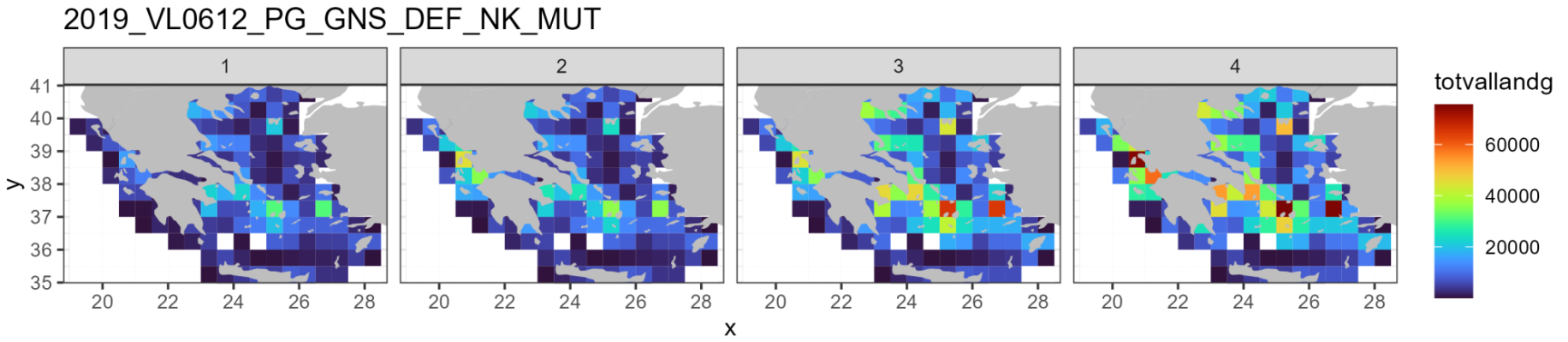
- Check difference between values estimated in table H and table A for the value of landings

joinFDI	Value (A)	Value (H)	check
GSA20_GRC_GNS_2019_VL0612_HKE_1_PG_NK_DEF	1179279	1179279	0
GSA20_GRC_GNS_2019_VL0612_HKE_2_PG_NK_DEF	2153463	2153463	0
GSA20_GRC_GNS_2019_VL0612_HKE_3_PG_NK_DEF	2543528	2543528	0
GSA20_GRC_GNS_2019_VL0612_HKE_4_PG_NK_DEF	1461903	1461903	0

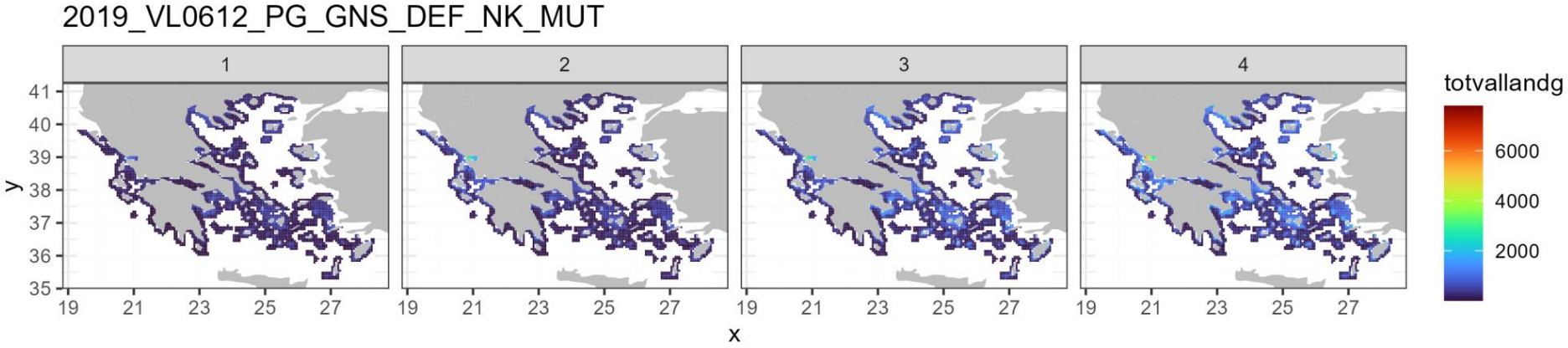
Outcomes from the main scripts

2) Estimating fishing effort, weight & value of landings

- Example plot of table H (spatial landings value)



- Example plot of table H (spatial landings value)



CINEA/EMFAF/2021/3.1.2/03/SC04/SI2.881222

Specific Contract 2021/3.1.2/03/SC04

Hosting, maintenance and further development of the Regional Database for the Mediterranean and Black Seas

We thank you for your attention

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