Report on collected Observatory data: Year 3

Deliverable 6.2

WP6. Observatory of pruning potential and utilization

uP_running

Take-off for sustainable supply of woody biomass from agrarian pruning and plantation removal

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Approvals

	Company
Author/s	CERTH
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ABBREVIATIONS

APPR: Agrarian Pruning and Plantation Removal

CERTH: Centre for Research and Technology Hellas

CIRCE: Research Centre for Energy Resources and Consumption

EC: European Commission

EuroPruning: Development and implementation of a new and non-existent logistics chain for biomass from pruning

uP_running: Take-off for sustainable supply of woody biomass from agrarian pruning and plantation removal

WP: Work Package

DEFINITIONS

Prime Mover	It is the pioneer who gives rise to a new biomass value chain. Other key actors might participate, but the chain would not have occurred without its initiative. Usually, it is the actor who invests and takes the largest part of the risk for the implementation of the value chain.
Observatory	The web-based, main tool that the uP_running project has developed in order to record and display "experiences" with APPR biomass such as field sampling / biomass productivity measurements, mechanized collection of APPR biomass and APPR value chains.

EXECUTIVE SUMMARY

APPR biomass is the accumulated biomass from agricultural pruning and plantation removal operations. In most cases APPR biomass is burnt in open fire or left on soil, thus being unexploited. In the uP_running project, a simple map-based web tool, the "Observatory" has been developed for registering and displaying different types of "experiences" related to APPR biomass: biomass productivity (tons of APPR biomass that can be obtained per hectare), collection experiences (based on field trials of various harvesting equipment) and value chains (existing, operating cases of APPR biomass utilization). By making these experiences publicly available and easy to find in one place, actors can be facilitated in initiating new APPR biomass value chains, through finding relevant information for their cases, identifying examples to replicate, etc.

Till the end of the uP_running project in June 2019, the Observatory web tool has collected 511 different APPR biomass experiences. Most of these refer to field measurements of biomass production from prunings, but a large number of mechanized collection experiences as well as value chains is also recorded. More than 40 % of these experiences have been identified or "triggered" during the implementation of the uP_running project, while the rest originate from literature sources or surveys of the EuroPruning project (FP7-312078). The large variability of the data points collected supports the usefulness of the uP_running Observatory in assisting prime movers in new value chains, interested stakeholders, consultants and researchers to identify APPR biomass experiences that are of relevance to their own cases.

The present report intends to give an overview of the APPR experiences that are included in the Observatory. Specific details on the individual recorded APPR experiences, please visit the Observatory webpage at: http://www.up-running-observatory.eu/.

The Observatory tool is expected to remain available for at least five years after the end of the project and it can be periodically updated with new data points, provided they are submitted to CERTH.

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INTRODUCTION

The current report constitutes **Deliverable D6.2 "Report on collected Observatory data"** of the uP_running project. The report is the result of work undergoing in **Task 6.2 "Registry of field data"** and **Task 6.3 "Registry of collection experiences and value chains"**.

The main objective of Task 6.2 is to improve the knowledge regarding the potential of APPR biomass by encouraging farmers to provide field data about the availability of such biomass resources in their own plantations.

The main objective of Task 6.3 is to improve the knowledge regarding the mechanized harvesting and utilization potential of APPR biomass by building a database for collection experiences and successful value chains.

The following data sources are utilized in order to meet the task objectives:

a) Literature data, e.g. published papers and reports. This includes results achieved and information collected through other European or national projects relevant to APPR biomass, e.g. EuroPruning and AGROinLOG.
b) Experiences directly resulting from the activities of the uP_running project, e.g. demonstrations of APPR harvesting, field measurements of APPR productivity.
c) Experiences that were not previously recorded but were identified and studied through the efforts of the uP_running project partners. This is mostly relevant for APPR value chains that were not previously studied by the EuroPruning project.

All data relevant to a specific APPR biomass experience (e.g. field measurement of potential, mechanized collection or value chain) are uploaded on the uP_running Observatory website using the standardized templates that were developed in the framework of Task 6.1 "Observatory development and creation of templates".

The main aim of Deliverable D6.2 is to facilitate the transmission of key-findings from the experiences recorded in the Observatory, e.g. through some basic statistical analysis or listing of recorded data.

This Deliverable report is prepared in English and covers experiences recorded by the uP_running Observatory from the project start (April 2016) till the end of project (June 2019); it is the third and final update of Deliverable D6.2.

1 PROGRESS OF POPULATING THE UP_RUNNING OBSERVATORY

The Observatory tool is a registry of APPR biomass productivity from field measurements, mechanized collection experiences and success cases of APPR value chains. It has been designed in a way that represents the data gathered through systematic questionnaires in order to help the users see and find material relevant to their own interests. In the framework of the uP_running project several experiences have been recorded and till its end (June 2019), the number for each experience type recorded in the Observatory web tool is as follows:

- ***393*** field measurements of biomass production from agricultural prunings
- ***8*** field measurements of biomass production from plantation removals
- ***65*** collection experiences for agricultural prunings
- ***3*** collection experience for plantation removals
- ***42*** APPR value chains

The Table 1 below summarizes the current status of populating the Observatory with experiences in comparison with the targets set by the uP_running project. Figure 1 compares the status of the Observatory tool at the end of the first and final project years; it is clear that many more experiences were made available on the Observatory, mostly due to the activities of the uP_running project.

It should also be noted that – thanks to an update in the Observatory platform – experiences that have been directly generated or assisted by the uP_running project (e.g. new field measurements, mechanized collection experiences from project demos, value chains commercialized with the assistance of project accompaniment) are now depicted with markers that include the uP_running logo (see Figure 1, left).

Table 1. Progress of the populating the uP_running Observatory with experiences (till June 2019).

uP_running Observatory collected data for APPR biomass experiences						
Source of experiences	Field measurements		Collection experiences		Value chains	
	Prunings	Uprooted	Prunings	Uprooted	Total	Flagships
Literature data	159	2	26	-	-	-
EuroPruning	71	-	19	1	16	-
Identified by uP_running	-	1	-	-	24	8
"Triggered" by uP_running	163	5	20	2	2	2
Total	**401** (232 literature + 169 uP_running)		**68**		**42**	**10**
Overall Project Target	**315** (150 literature + 165 uP_running)		**50**		**20**	**10**

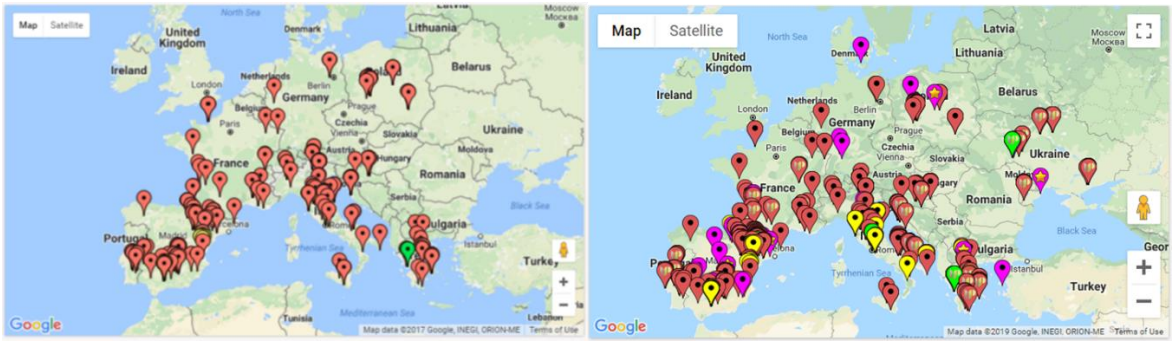

Figure 1. Home page of the Observatory Tool. Left: Progress of year 1. Right: Progress of year 3 (http://www.up-running-observatory.eu/

2 BIOMASS PRODUCTIVITY FOR AGRICULTURAL PRUNINGS

2.1 Data sources

Till the end of June 2019, the Observatory has successfully populated with 394 data points regarding field measurements related to biomass productivity from agricultural prunings. The distribution of the origin of those data points is as follows:

- **159** data points were collected from various literature sources ([1],[2],[3],[4],[5],[6],[7],[8]); most of these sources were previously studied by CIRCE in the framework of the EuroPruning project ([9]).
- **71** data points originate from surveys performed in the framework of the EuroPruning project; the results of those surveys were communicated to CERTH by CIRCE.
- **163** data points were collected from new field measurements performed by the uP_running project partners and transferred to CERTH till June 2019.

Table 2. Summary of field measurements contained in the Observatory by crop, type of information source, irrigation regime and country.

Number of recorded experiences					
Crop group	Total	Literature	EuroPruning surveys	uP_running field measurements	Countries
Vineyard	**142**	57	13	72	Spain, Italy, Greece, France, Portugal, Ukraine, Croatia
Olive	**86**	43	7	36	Spain, Italy, Greece, Portugal, Croatia
Seed fruit (apple, pear, fig, kiwi, guava)	**74**	31	23	20	Spain, Italy, Greece, France, Ukraine, Croatia, Germany, Poland, Mexico

Number of recorded experiences					
Crop group	Total	Literature	EuroPruning surveys	uP_running field measurements	Countries
Stone fruit (peach, cherry, apricot, plum, nectarine)	**62**	16	20	26	Spain, Italy, Greece, France, Portugal, Ukraine, Croatia, Germany, Poland
Citrus (orange, lemon)	**7**	2	5	-	Spain, Italy
Nuts (almond, walnut)	**20**	10	3	7	Spain, Italy, Croatia
Other (Pinus pinea)	**2**	-	-	2	Portugal

2.2 Pruning biomass productivity per crop type

In order to assess the biomass productivity from prunings, two types of ratios are commonly employed in the literature. The first, is the biomass production per hectare (t/ha), referred as Residue to Surface Ratio (RSR). The second type refers to the amount of prunings per amount of fruit and is known as the Residue to Product Ratio (RPR).

In the literature, several sources can be found from local or general biomass assessment studies. However, when aiming to produce a biomass assessment in large scale a single ratio is used for each crop for whole territory.

According to a previous detailed study carried out in 2007, the EuroPruning project came to the conclusion that the RSR ratios showed non-acceptable values to reproduce the local reality, in contrast with the RPRs ratios which were proposed as a better approach. Nevertheless, RSR ratios were used in most of the EuroPruning project outputs, since the use of RPRs requires to measure or to know the yield production of fruit.

In the uP_running Observatory, RSRs are also the main data recorded regarding the pruning biomass productivity from a field. By presenting a wide range of information about the field conditions, interested parties can check whether a data point with a given RSR value would be a good match for their own fields. Some further information about the RPRs measured or estimated at the new uP_running field measurements is presented in this report.

Considering the results that are recorded in the Observatory, the main factors that appears to be influencing the biomass productivity are the pruning method that is implemented, the pruning frequency, as well as the climate conditions prevailing in every area. Depending on the pruning method that is performed (structure, maintenance pruning, or removal of old branches, etc.) and how often this procedure happens (once/twice every year, once every two/tree years) the pruning productivity may differ extremely. Concerning the climate conditions, they can play a major role in the growth of the crop and therefore to the amount of the collected pruning. Temperatures may have important consequences on the production of fruits by causing early or late start of the

reproductive stage (e.g. if a crop undergone aridity the growth of the trees will be deteriorated and the pruning method will be less strict than it would be if there was enough moisture in the ground. As a result, the pruning will be much less).

2.2.1 Olive trees

Prunings that are collected from olive trees consist a large amount of biomass which is not utilized properly. The EuroPruning project recorded biomass productivities ranging from 0.40 t/ha dry material (the minimum value) to 10.90 t/ha dry material (the maximum recorded value in a case where the pruning frequency was once every three years). The pruning frequency as it is recorded from all the APPR experiences is ranged between one and two times per year, and rarely tree times of year.

Overall, the registered data points on the Observatory tool concerning olive tree pruning are 86; Figure 2 presents the location of all the recorded field measurement experiences.

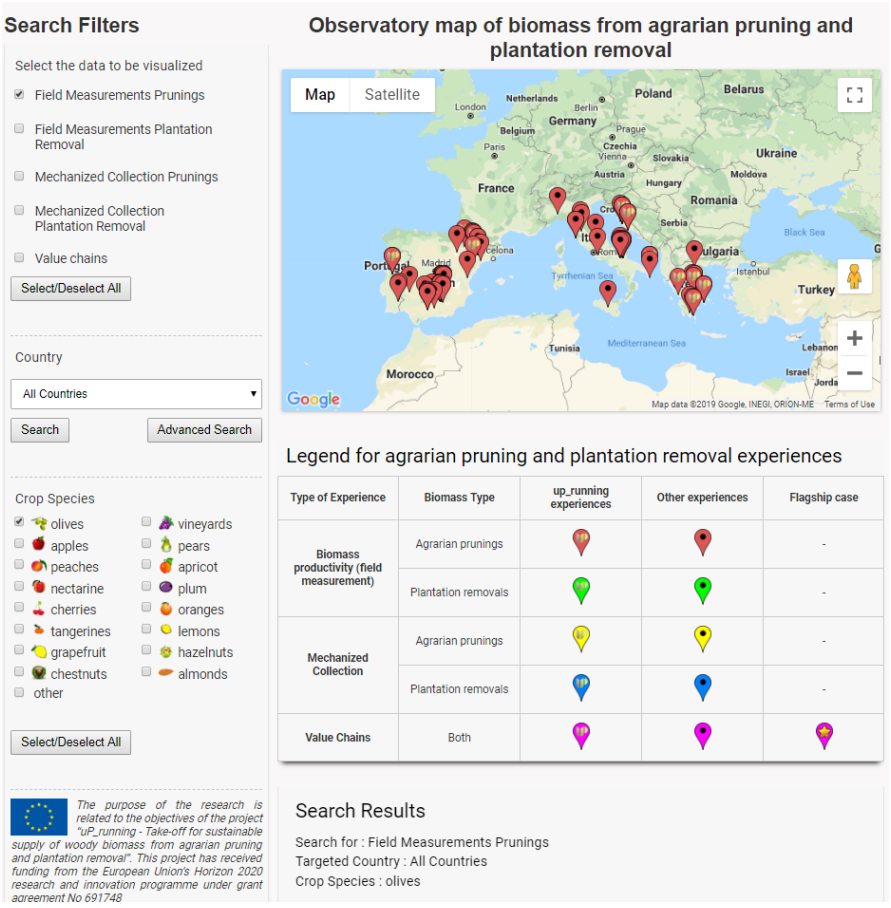

Figure 2. Observatory screenshot with biomass productivity measurement from olive tree prunings (till June 2019).

In Table 3, the results from the 86 measurements that are both performed and recorded in olive trees during the uP_running and EuroPruning project up to date are presented. As we can see in the table below 36 new measurements are recorded due to the framework of the uP_running project and the biomass productivity of each country was calculated using the given moisture content, which in the most cases was close to 35 %. An exception consists the case of Italy where

the maximum value of biomass productivity reaches the 14.40 t/ha of dry biomass. It is believed that the main reason for this deviation is the vigorousness of the certain olive tree variety as well as the pruning frequency, which in this case was twice a year. In this point we should mention that an indication of the errors can be generated when a biomass assessment fails to take into account local conditions.

Table 3. Summary of biomass productivity measurements from olive groves included in the uP_running Observatory (till June 2019).

Biomass productivity of olive trees			
Source	# data	Biomass productivity (t/ha, dry)	
		Minimum	Maximum
uP_running field measurements: Croatia	5	0.82	1.64
uP_running field measurements: Portugal	2	7.41	8.53
uP_running field measurements: Italy	13	0.59	14.40
uP_running field measurements: Greece	10	2.25	9.31
uP_running field measurements: Spain	6	1.06	8.21
Literature & EuroPruning	50	0.40	10.90
(Velázquez-Martí et al., 2011)*[10]	N/A	0.40	4.60
* *Reported valued refer only to the wood part of the prunings (e.g. the leaf fraction is excluded)*			

2.2.2 Vineyards

As it is mentioned above, pruning from olive trees consist a large amount of biomass. However, vineyard residues also consist a serious biomass potential, if we take into account that data gathered from literature and EuroPruning project are referred to biomass productivities from 0.10 t/ha dry material to 2.70 t/ha dry material.

The registered data points on the Observatory tool concerning vineyard APPR are currently 142 and are displayed in the following Figure 3.

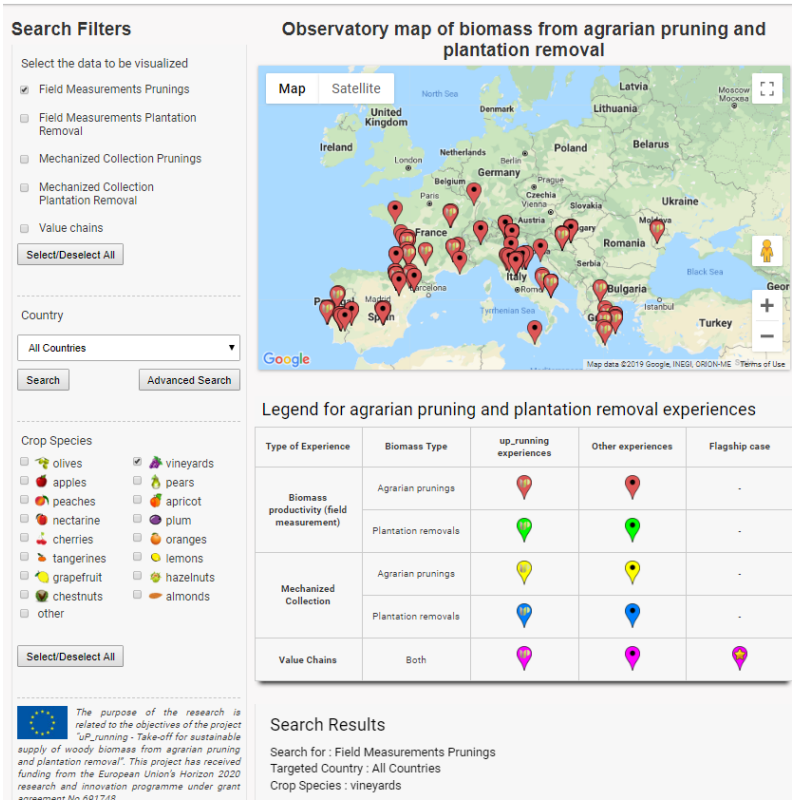

Figure 3. Observatory screenshot with biomass productivity measurement from olive tree prunings *(till June 2019).*

In Table 4, the results from the 142 measurements that were both performed and recorded in vineyard crops during the uP_running and EuroPruning project up to date, are presented. Looking closely at the table below we can see that the recorded uP_running measurements are in total 72 data points much more than the olive field measurements. Moreover, we can observe that the maximum vineyard biomass productivity ranges in 2.60 t/ha dry biomass, apart from two occasions, Portugal and Italy. In the case of Italy this deviation is based on the pruning type (grafting pruning) that was followed in some cases, and as a result the biomass productivity was much higher than it was in the other measurements. A particularly high biomass productivity result (7.80 t/ha dry matter) was obtained in Portugal through a measurement by project partner CONFAGRI; this extraordinary value is believed to be due to the very high planting density (10,000 trees per hectare) and the fact that it is coming from a modern and very professional vineyard.

It should be mentioned that the dry matter biomass productivity was calculated considering the on-field measurement of the wet biomass production and measurements or estimations of the moisture content of the prunings at the time of measurement. Typically, the moisture content during the on-field measurements ranged between 40 – 50 %.

Table 4. uP_running field measurements from vineyards (*till June 2019*).

Biomass productivity of vineyards			
Source	# data	Biomass productivity (t/ha, dry)	
		Minimum	Maximum
uP_running field measurements: Croatia	10	0.44	1.63
uP_running field measurements: France	17	0.52	1.76
uP_running field measurements: Portugal	7	1.47	7.80
uP_running field measurements: Spain	8	0.56	2.07
uP_running field measurements: Ukraine	3	1.43	2.42
uP_running field measurements: Italy	12	0.53	4.20
uP_running field measurements: Greece	15	0.07	2.60
Literature & EuroPruning	70	0.10	2.70

2.2.3 Fruit Trees

The Observatory tool includes data entries from fruit trees as shown in Figure 4. Fruit trees can be categorized into seed fruits and stone fruits. A total of 137 data points are registered.

Figure 4. Observatory screenshot with biomass productivity measurement from fruit tree prunings (till June 2019)

Seed fruit

Seed fruit tree plantations are widespread along Europe, being main varieties apple and pear species. In this category, the minimum value is 0.06 t/ha of dry biomass, measured in apple tree prunings in Poland. The maximum value is 15.13 t/ha of dry biomass, again for apple trees but in France. The above values came from EuroPruning data surveys and different literature sources, where the moisture content of these data points are difficult to be identified.

The collected experiences in the Observatory for this category are 74 data points, 20 of which came from field measurements performed by the uP_running project partners. A summary is presented in Table 5.

In this category it is worth to mention one exotic crop, guava, which is measured in Mexico (2013) and it is recorded on the Observatory after communication with the author (2017) [8].

Table 5. uP_running field measurements from seed fruit plantations (till June 2019).

Biomass productivity of seed fruit plantations				
Source	# data points	Type of crop	Biomass productivity (t/ha, dry)	
			Minimum	Maximum
uP_running field measurements: Ukraine	18	Apples	0.90	5.50
uP_running field measurements: Greece	1	Kiwi	-	9.44
uP_running field measurements: Spain	1	Pears	-	2.46
Literature & EuroPruning	54	Apples, pears, fig	0.06	15.13

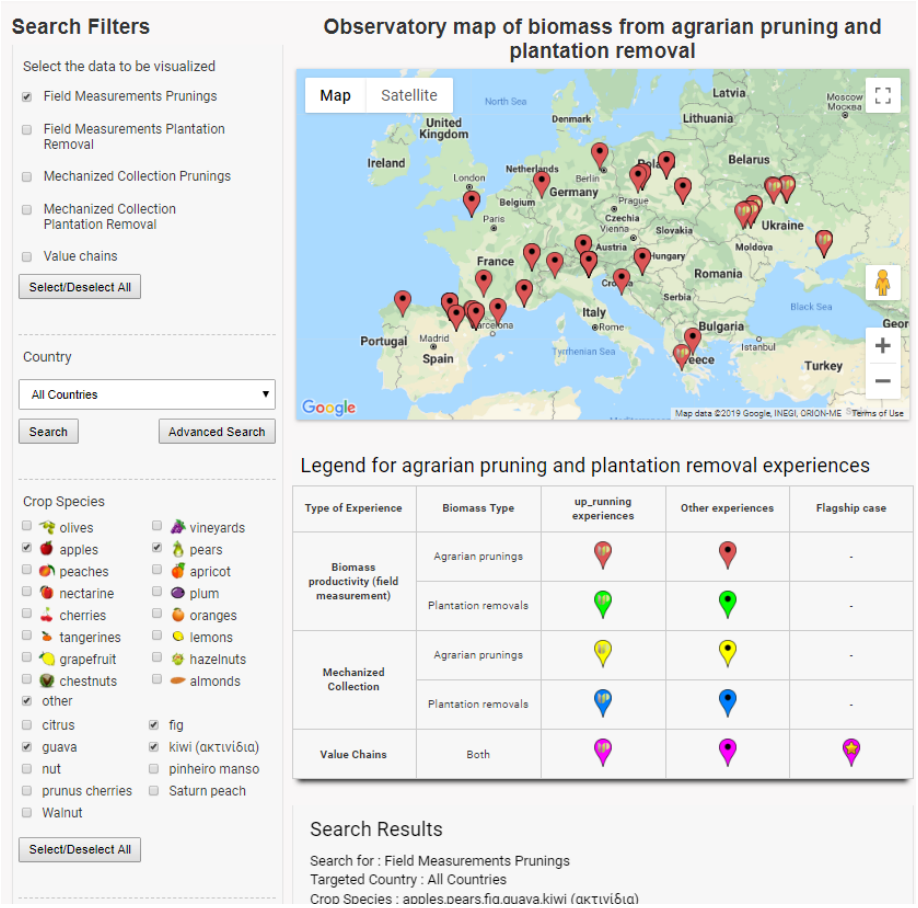

Figure 5. Observatory screenshot with biomass productivity measurement from seed fruit tree prunings (till June 2019).

Stone fruit

Stone fruits group includes species such as peach, apricot, nectarine, plum, cherries and sour cherries. The collected experiences in the Observatory for this category amount to 63 data points from locations in Poland, Spain, Croatia, Italy, Ukraine and France. The maximum and the minimum values for all the stone fruit categories are shown below in Table 6. The maximum value for all the species was 14.22 t/ha of dry biomass (in a case of grafting pruning) and the minimum was 0.30 t/ha of dry biomass. In most cases, the moisture content is between 40 – 50 %. In the following table are also included new field measurements which took place in the framework of uP_running project and are now presented on the Observatory tool as uP_running experiences.

Table 6. Typical values of the stone fruit plantations as they collected from the APPR experiences (till June 2019).

Biomass productivity of stone fruit plantations				
Source	# data	Type of crop	Biomass productivity (t/ha, dry)	
			Minimum	Maximum
uP_running field measurements: Ukraine	5	Cherries, Peaches, Plum, Apricot	1.06	5.08
uP_running field measurements: Italy	4	Peaches	1.10	4.55
uP_running field measurements: Greece	2	Cherries, Plum	0.57	3.92
uP_running field measurements: Spain	16	Peaches, Nectarine	0.98	14.22
Literature & EuroPruning	36	Cherries, Peaches, Plum, Apricot	0.30	5.38

Below in Figure 6, all the recorded APPR experiences, regarding the stone fruit prunings, are displayed.

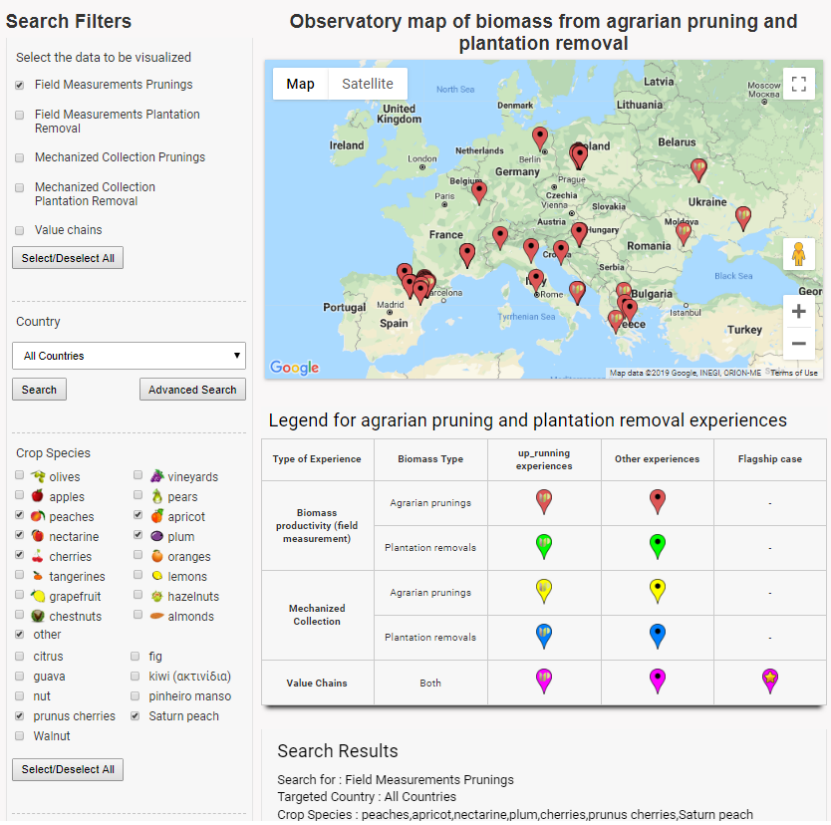

Figure 6. Observatory screenshot with biomass productivity measurement from stone fruit tree prunings (till June 2019).

2.2.4 Citrus Trees

Citrus species are cultivated in warm coastal areas in Europe, mainly in Spain, Portugal, Greece and Italy. These plantations usually follow intensive cultivation with irrigation and their pruning residues are branches with wood and leaves because of their perenniality. Currently, the Observatory has registered 7 field measurements of biomass productivity from fruit trees, coming from EuroPruning survey data and literature sources. The moisture content is typically around 40 – 50 %. It is worth to mention that according with the following paper [11], citrus plantation residual biomass is ranged between 2.4 and 4.7 t/ha dry biomass.

In Figure 7, all the recorded APPR experiences, regarding the citrus trees prunings, are displayed.

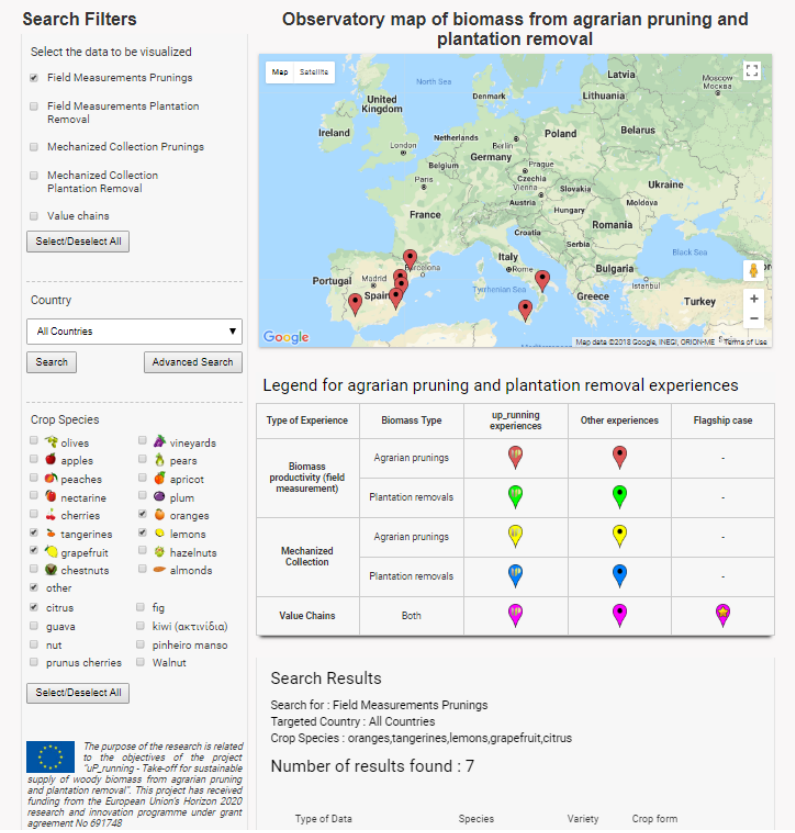

Figure 7.Observatory screenshot with biomass productivity measurement from citrus tree prunings (till June 2019).

2.2.5 Nut Trees

Nut fruit group include crops like almonds, hazelnut, walnut and chestnut, among others. Whereas almond is a specie with low requirements of cold to fit its phenology to local climates, other nut crops are more adapted to cool areas, and so, are distributed in oceanic and continental climates. Just like citrus plantations, nuts trees have also a small amount of pruning biomass. The collected experiences in the Observatory are 20, mostly coming from measurements in Spain. In Table 7 and Figure 8 below, the collected data from all the nuts trees plantations are shown. As we can see there is one uP_running experience in the wide area of Italy in almonds crop. The biomass productivity is much higher than the other sources, due to the pruning frequency (once every three years). The moisture content is typically around 40 – 50 %.

Table 7. Typical values of the nuts trees plantations as they collected from the APPR experiences (till June 2019).

Biomass productivity of nuts trees plantations				
Source	# data	Type of crop	Biomass productivity (t/ha, dry)	
			Minimum	Maximum
uP_running field measurements: Italy	1	Almonds	-	25.00

uP_running field measurements: Spain	6	Almonds, Hazelnuts	0.03	7.63
Literature & EuroPruning	13	Almonds, Hazelnuts, walnuts	0.18	6.93

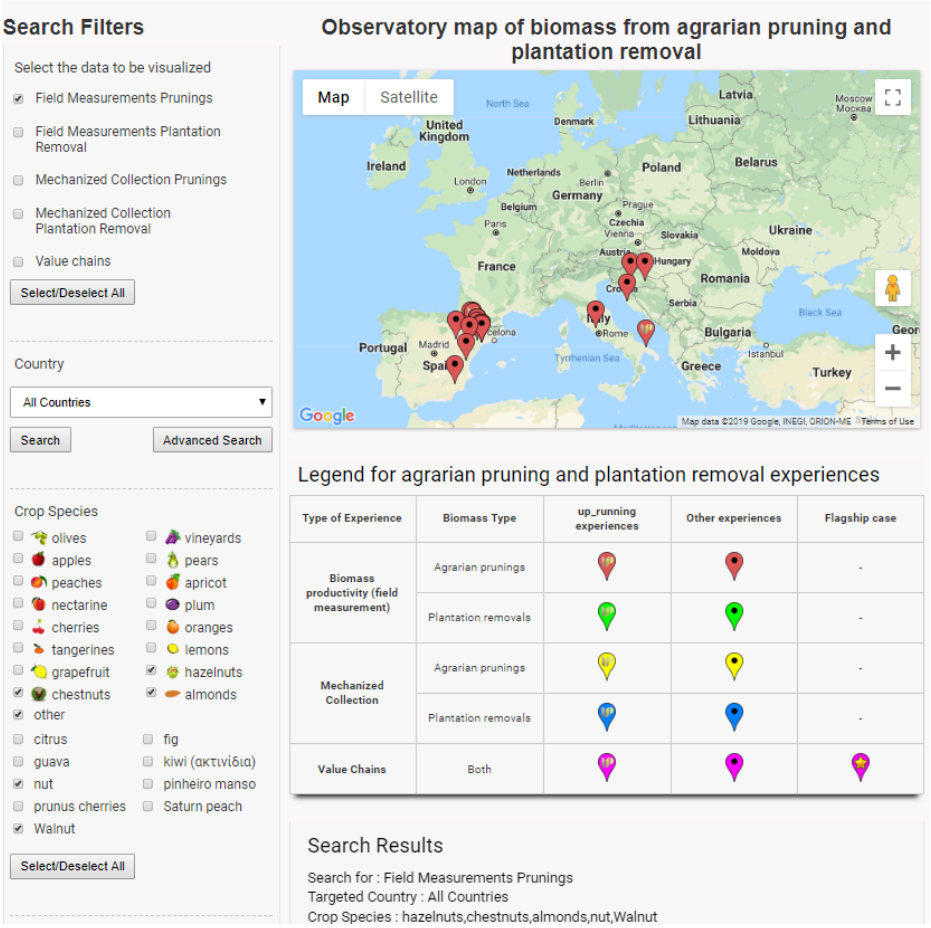

Figure 8. Observatory screenshot with biomass productivity measurement from nut tree prunings (till June 2019)

3 BIOMASS PRODUCTIVITY FOR PLANTATION REMOVALS

Recorded experiences with the biomass productivity from plantation removals are much rarer than prunings. The main reason is believed to be the large cycle or infrequency of such operations.

Currently, the Observatory contains 8 experiences concerning the biomass productivity from plantation removal, 6 of which are recorded during the uP_running project. The other 2 experiences come from published papers: [12], [13]. A summary of the recorded experiences related to biomass productivity from plantation removal biomass is presented in Table 8 and Figure 9 below.

During the course of the uP_running project, it is expected that it will be possible to collect further biomass productivity experiences with uprooted material.

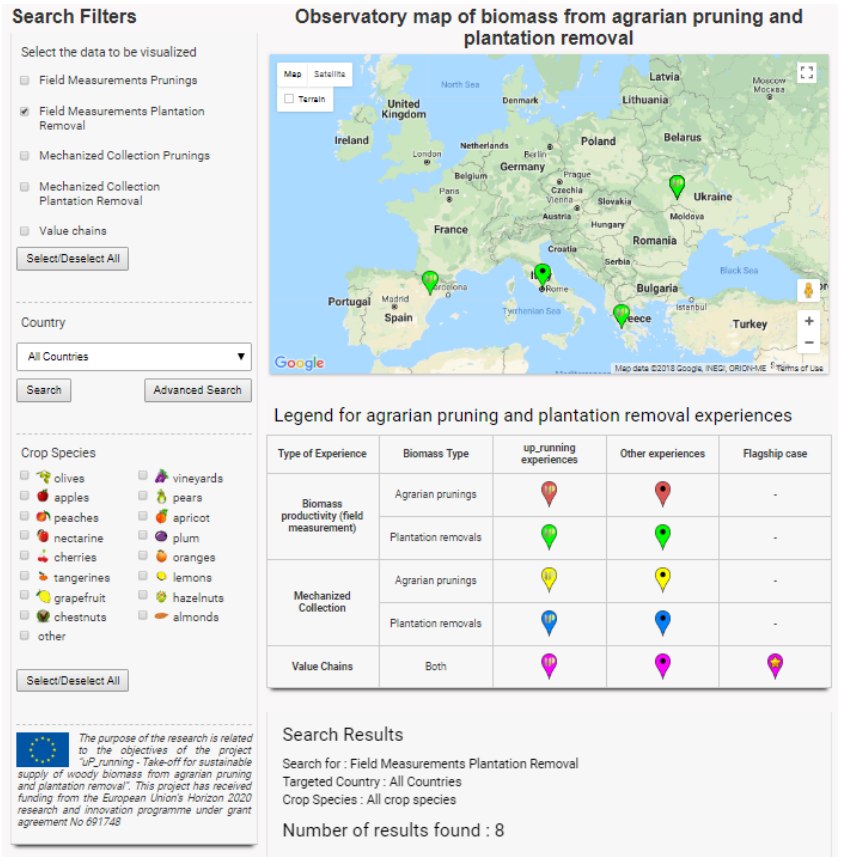

Figure 9. Observatory screenshot with biomass productivity measurement from plantation removals in Europe (till June 2019)

Table 8. Field measurements plantation removals experiences uploaded on the Observatory (till June 2019).

Summarize of the field measurements plantation removals experiences						
Source	Country	Type of crop	Age	Reason for removal	Biomass productivity (t/ha, dry)	Part of plantation measured
(Alissa Kendall & Elias Marvinney, 2015), [12]	United States	almonds	25	Old age	24.28	Full tree
(Stefania Proietti et.al 2014), [13]	Italy	olives	11	Research study for carbon footprint	4.60	Only stem
					15.12	Only branches
uP_running (field measurement)	Ukraine	plum	45	Old age	10.59	Aereal part (stem + branches)
uP_running (field measurement)	Ukraine	apples	45	Old age	20.93	Aereal part (stem + branches)
uP_running (field measurement)	Ukraine	cherries	46	Old age	14.31	Aereal part (stem + branches)
uP_running (field measurement)	Ukraine	pears	45	Old age	31.00	Aereal part (stem + branches)
uP_running (interview with farmer)	Greece	oranges	35	Change of crop	44.00	Only stem
uP_running (field measurement)	Spain	nectarine	9	Change of variety	9.37	Aereal part (stem + branches)

4 COLLECTION EXPERIENCES OF APPR BIOMASS

Collection experiences for APPR biomass have up to now been uploaded in the Observatory from two main data sources: literature papers and results of uP_running WP3 demonstrations. In total, 68 collection experiences have been uploaded on the Observatory (Figure 10).

Several scientific papers focusing on the evaluation of different pruning harvesting systems have been identified up to now ([14], [10], [15], [16],[17], [18]). From these papers, it was possible to compile data for 26 different collection experiences, which are uploaded on the Observatory as separate data points. A brief summary of these literature collection experiences (without the Europruning ones) is presented in Table 9. Additionally, 15 more experiences derived from the EuroPruning project have been uploaded [22].

During the second year of the uP_running project partners, in collaboration with selected prime movers in demo countries (Italy, Greece, Spain, Ukraine), have organized several demonstrations, which included the collection of various types of APPR biomass. Around 20 such new experiences (typically one per demonstration) were generated and have been uploaded on the Observatory,

Table 10. Among these are the first recorded experiences with plantation removal biomass in Ukraine (apple trees) and Spain (nectarine trees).

It is also interesting to note that several uP_running demonstrations were performed with static chippers, a harvesting system that has not been widely studied in the literature. Hence, the Observatory is taking a further step towards enriching the available information on APPR biomass harvesting systems, as was one of its original intentions.

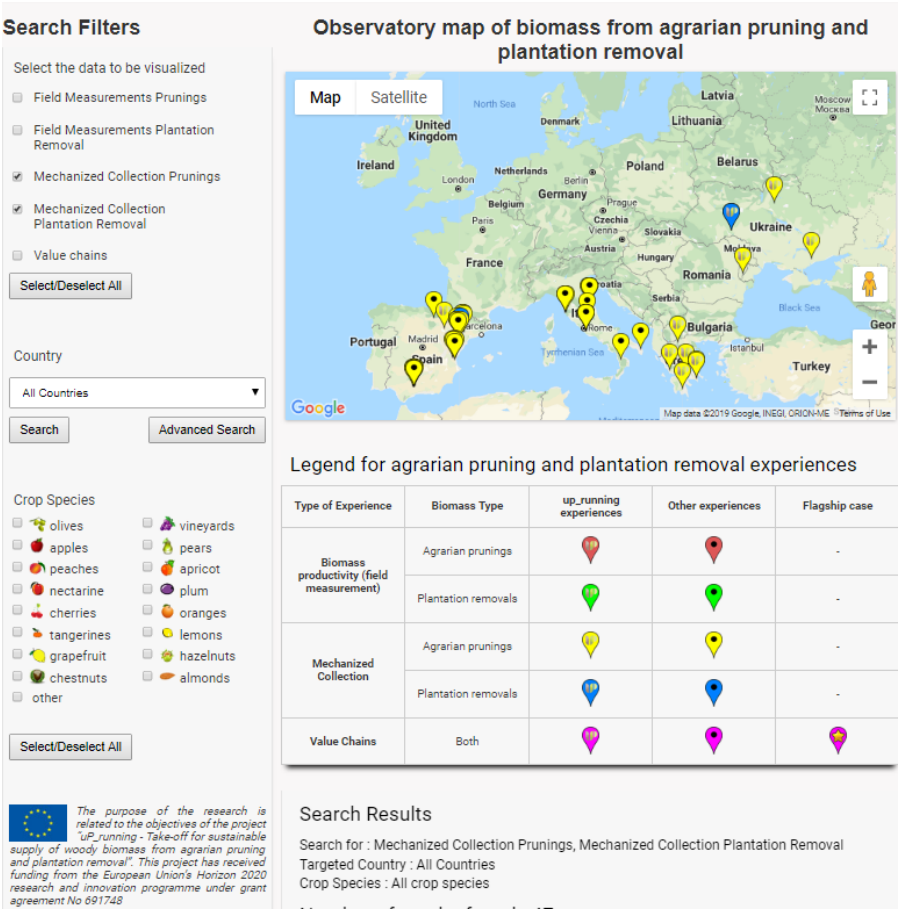

Figure 10. Observatory screenshot with collection experiences of APPR biomass (*till June 2019*).

Table 9. Collection experiences uploaded on the Observatory from literature sources (till June 2019).

Summarize of the literature collection experiences					
Source	# data	APPR type	Location	Harvesting method	Models
(Spinelli R & Picchi G, 2010), [14]	10	Olive tree prunings	Palenciana, Spain & Follonica, Italy	Rear mulcher/chipper + trailer	Jordan
				Automotive shredder/chipper with rear trailer	SAT-4
(Velázquez-Martí B & Fernández-González E, 2009), [10]	5	Olive tree prunings	Valencia, Spain	Rear mulcher/chipper + trailer	Promagri 2000 Jounes Atila Pick-up S Biomasa 180
				Rear mulcher/chipper + bin	Serrat Olipack T1800;

					Berti Picker C180
(Spinelli R., N. Magagnotti, and C. Nati., 2010), [2]	4	Vineyard prunings	Montecarotto, Italy	Rear baler	LERDA 900 L (square); CAEB MP 400 S (round)
				Rear mulcher/chipper + big-bags	Nobili TRP 145 RP
				Rear mulcher/chipper + integrated bin	Berti PC 140
(Spinelli R., R.S., Magagnotti N., Nati C., Pari L., Vanneste J. L., 2012), [15]	3	Kiwi prunings	Cisterna di Latina, Italy	Rear mulcher/chipper + integrated bin	Facma Comby 20
				Rear mulcher/chipper + re-usable bin	Nobili TRP 140 + forwarder (Sossai "Cat")
				Rear baler	CAEB MP 400
(Assirelli A., A.A., Croce S., Spinelli R., Santangelo E., Pari L., 2013), [16]	1	Olive tree prunings	Castrigliano de' Greci, Italy	Rear mulcher/chipper + integrated bin	Tierre Futura 160 Omat TSB 1900 Sgarbi TR-RAC Facma Comby TR 200 Berti Piker-Kargo 200
				Rear mulcher/chipper + trailer	Nobili TRP-CV 145
(Pari L., 2002), [18]	2	Olive tree prunings, Vineyard prunings	Sabina, Cosenza, Italy	Rear shredder	Haychopper Gallignani P120
				Rear baler	Arbor RS 170
(M.-A. Kougioumtzis, E.Karampinis, P.Grammelis, E. Kakaras, 2019)[21]	1	Olive tree prunings	Agios Konstantinos, Greece	Rear mulcher/chipper + integrated bin	Facma Comby TR 200
Total	**26**				

Table 10. Collection experiences uploaded on the Observatory collected from the uP_running WP3 demonstrations, EuroPruning project as well (till June 2019).

Summarize of the uP_running collection experiences					
Source	# data	APPR type	Location	Harvesting method	Models
uP_running WP3 demo	1	Olive tree prunings	Trapezonti Lakonias, Greece	Static chipper	YAMACHIPPER VR35-PTO Heavy duty
uP_running WP3 demo	1	Olive tree prunings	Naousa, Greece	Static chipper	Husmann H 5
uP_running WP3 demo	2	Olive tree prunings, vineyard prunings	Koropi, Greece	Static chipper	Bugnot BVE8
uP_running WP3 demo	1	Kiwi prunings	Astakos, Greece	Rear mulcher/chipper + integrated bin	Facma Comby TR 200
uP_running WP3 demo	1	Olive tree prunings	Anthochori Voiotias, Greece	Rear mulcher/chipper + integrated bin	Facma Comby TR 200
uP_running WP3 demo	1	Apple tree prunings	Petrymany village, Ukraine	Static chipper	Hemmel RM51
uP_running WP3 demo	1	Apple tree prunings	Nova Oleksandrivka village, Ukraine	Static chipper	URBAN TR70
uP_running WP3 demo	1	Vineyard prunings	Bolgrad, Ukraine	Static shredder	DM-F-4 modified
uP_running WP3 demo	1	Apple tree prunings	Kostiantynivka village, Ukraine	Static chipper	Heizohack HM 8-400
uP_running WP3 demo	1	Apple tree uprooting	Zhytnyky village, Ukraine	Static chipper	Hemmel RM41
uP_running WP3 demo	1	Nectarine prunings	Sudanell, Spain	Rear chipper + bin in front	SERRAT "Biomass 100"
uP_running WP3 demo	1	Vineyards prunings	Fuendejalon, Spain	Static shredder	VERMEER HG6000
uP_running WP3 demo	1	Peaches prunings	Fraga, Spain	Static chipper	Junkkari 250

Summarize of the uP_running collection experiences					
Source	# data	APPR type	Location	Harvesting method	Models
uP_running WP3 demo	1	Peaches prunings	Chiprana (Caspe), Spain	Rear chipper + bin in front	SERRAT "Biomass 100"
uP_running WP3 demo	1	Nectarine uprooting	Miralsot, Spain	Static shredder	Doppstadt AK-430
uP_running WP3 demo	1	Olive tree prunings	Lucera, Italy	Rear mulcher/chipper + integrated bin	Nobili TRP-175 RT
uP_running WP3 demo	1	Olive tree prunings	Cerignola, Italy	Rear mulcher/chipper + integrated bin	Facma Comby TR140 +TR200, Caravaggi BIO1250
uP_running WP3 demo	1	Olive tree prunings	Modugno, Italy	Rear mulcher/chipper + integrated bin	Nobili TRP-175 RT
uP_running WP3 demo	1	Olive tree prunings	Lucera, Italy	Static chipper	Caravaggi BIO1250
Total	**20**				

Summarize of the EuroPruning collection experiences					
Source	# data	APPR type	Location	Harvesting method	Models
EuroPruning Project	1	Vineyards prunings	Carinena, Spain	Harvest with rear baler	PIMR-Model PRB 1.75 baler
EuroPruning Project	1	Olive tree prunings	Escatron, Spain	Harvest with mulcher/chipper in front	SERRAT (model biomass 150)
EuroPruning Project	2	Peaches prunings	Fraga, Spain	Harvest with rear mulcher/chipper and big-bags	ONG SNC (PC50 Chipper)
EuroPruning Project	1	Peaches prunings	Fraga, Spain	Harvest with rear baler	PIMR-Model PRB 1.75 baler
EuroPruning Project	1	Olive tree prunings	Fuendejalon, Spain	Harvest with rear baler	PIMR-Model PRB 1.75 baler
EuroPruning Project	1	Apple tree prunings	Glindow (Potsdam), Germany	Harvest with rear mulcher/chipper and bin	ONG SNC (PC50 Chipper)
EuroPruning Project	1	Apple tree prunings	Glindow (Potsdam), Germany	Harvest with rear baler	PIMR-Model PRB 1.75 baler
EuroPruning Project	2	Olive tree prunings	Mazaleon, Spain	Harvest with rear mulcher/chipper and big-bags	ONG SNC (PC50 Chipper)
EuroPruning Project	2	Apple tree prunings	Przybroda, Poland	Harvest with rear baler	PIMR-Model PRB 1.75 baler
EuroPruning Project	1	Plum prunings	Schmergow, Germany	Harvest with rear mulcher/chipper and bin	ONG SNC (PC50 Chipper)
EuroPruning Project	1	Plum prunings	Schmergow, Germany	Harvest with rear mulcher/chipper and big-bags	ONG SNC (PC50 Chipper)
EuroPruning Project	1	Peaches uprooting	Fraga, Spain	Aereal part of the tree felled with a machinery	Regular Forestry chipper
Total	**15**				

5 APPR BIOMASS VALUE CHAINS

Till the end of the project, 42 value chains experiences have been uploaded on the Observatory.

- 16 of these experiences have been previously identified and initially studied by the EuroPruning project [19]; the results from EuroPruning have been transferred to the APPR value chains questionnaire developed by the uP_running project and then uploaded on the Observatory.
- 24 value chains, not previously identified by EuroPruning, were studied in the course of the uP_running project activities. These initiatives were engaged and interviewed by various uP_running partners using the standardized value chain questionnaire, which was then uploaded on the Observatory.
- 2 value chains (AgriToppi and Triada-MK) that were intensely supported by the project through the accompaniment activities of WP3.

A summary of the recorded value chains so far is presented in Table 11.

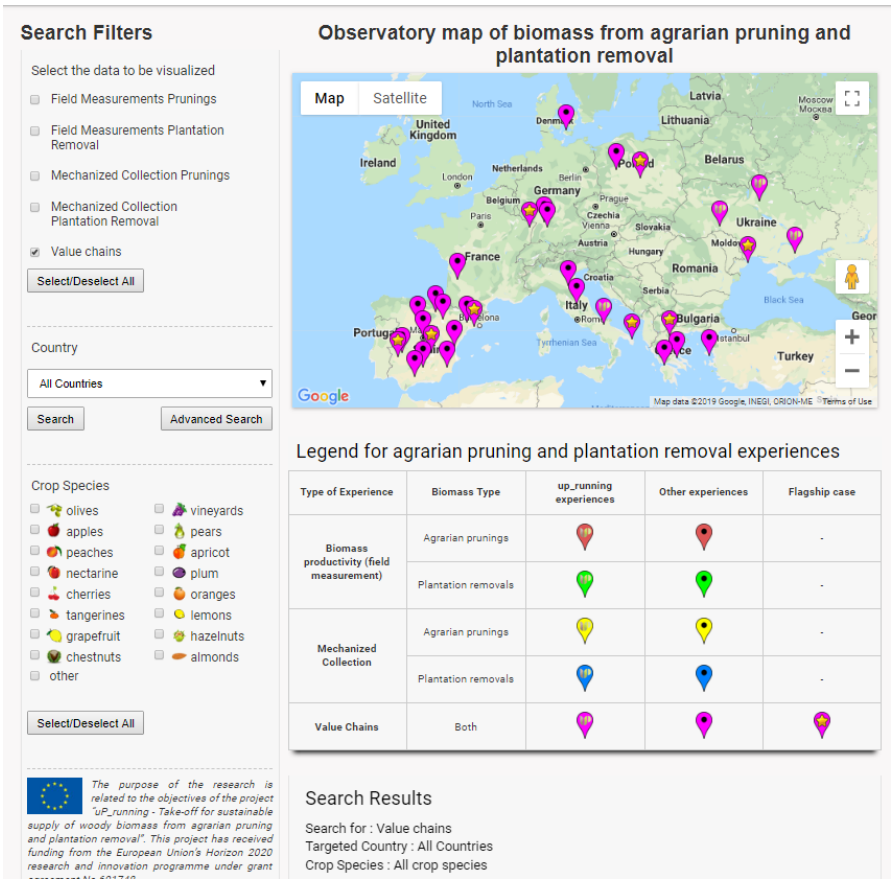

Figure 11. Recorded APPR value chains (till June 2019)

Table 11. Summary information about the APPR value chains recorded in the Observatory (till June 2019). Flagship cases marked in bold. Underlined cases identified or triggered by uP_running.

Summarize of the recorded APPR value chains			
Typical APPR biomass mobilization per case (t/y)	# cases	Value chain prime movers	Type of cases
< 500	20	**Domaine Xavier Muller (France)** BIOTONOS (Spain) **GOSPODARSTWO SADOWNICZE (Poland)** SCEA Vignobles Jean-Marie CARRILLE (France) S.C.A. Ntro. Padre Jesus (Spain) Stefano Barbien (Italy) Land-und Forstwirtschaftliches Lohnunternehmen Timo Kirn (Germany) Communidad de Regantes de Ria y Toixima (Spain) Vesterled frugtplant (Denmark) **Vilafranca del Penedés / Vineyards4heat (Spain)** Roiniczo Sadownicze Gospodarstwo (Poland) Cantine Giorgio Lungarotti (Italy) Bodegas Emina (Spain) **AgriToppi (Italy)** Agios Konstantinos Agricultural Cooperative & NUTRIA S.A. / AGROinLOG (Greece) Marqués de Murrieta (Spain) Aegean Biomass (Greece) Bodegas Torres (Spain) Aenaon Bioenergies (Greece) Novooleksandrivske farm (Ukraine)	Domestic heating (self-consumption), other heating applications (e.g. winery,municipal heating, small agro-industries), Biomass to Market, pellet / chip production
500 – 2,100	6	Stadt Land Fluss (Germany) **ITC Shabo (Ukraine)** AREX Medio Ambiente (Spain) **Triada-MK (Ukraine)** SOLAMUR (Spain) BLACK SEA fruit company (Ukraine)	Heat production in larger agro-industries, co-firing fuel for biomass CHP / power plants, Biomass to Market, Heat production for self-consumption at fruit company offices and for municipal heating
2,500-8,000	4	**FIUSIS (Italy)** Oleícola EL TEJAR (Spain) AGROENERGETICA DE PALENCIANA, S.L. (Spain) Enemansa (Spain)	Power production (exclusively from APPR)

Summarize of the recorded APPR value chains			
Typical APPR biomass mobilization per case (t/y)	# cases	Value chain prime movers	Type of cases
8,000	1	**EAMEB (Greece)**	Wood chips from plantation removals
8,000 - 10,000	1	NUFRI (Spain)	Hog fuel from plantation removals
Up to 20,000	9	**Pelets de la Mancha (Spain)** **ENCE Mérida (Spain)** AGROENERGETICA DE BAENA, S.L. (Spain) VETEJAR, S.L. (Spain) Bioenergía Santamaría (Spain) Complejo Energetico Ence Huelva 1 (Spain) Complejo Energetico Ence Huelva 2 (Spain) BIOELÉCTRICA DE LINARES (Spain) BIOMASAS DE PUENTE GENIL (Spain)	Large-scale pellet / chip production, Power production (APPR as part of the fuel mixture)
> 84,000	1	Valoriza Energia O&M (Spain)	Power production (APPR as part of the fuel mixture)
Total	**42**		

It is interesting to note that most value chains identified so far belong to the "self-consumption" model, where a single farmer, a small agro-industry or other entity is using the APPR biomass available in their location to produce heat in the own facilities. However, there are also cases of using larger agro-industries using APPR for process heat, APPR in power production (either as a stand-alone fuel or as part of the fuel mixture) and production of solid biofuels (wood chips or pellets) from APPR biomass. This range of cases exemplifies the variability and versatility of APPR biomass utilization.

Out of the value chains investigated, 10 (Domaine Xavier Muller, Vilafranca del Penedés / Vineyards4heat, ITC Shabo, Pelets de la Mancha / Athisa Group, FIUSIS, EAMEB, ENCE Merida, GOSPODARSTWO SADOWNICZE, Triada-MK, AgriToppi) have been selected as exemplary ("flagship") cases of APPR biomass utilization in Europe. These cases have been the subject of intense study in Deliverables D6.3 [20] and D6.4 [23] of the uP_running project. It is also interesting to note that the last two flagship cases have been directly supported by the uP_running project.

6 CONCLUSIONS

The uP_running Observatory tool was created with the aim of becoming a simple-to-use web-based map tool that registers a wide range of APPR biomass experiences, mostly from Europe. At the end of the project, the Observatory web tool has been populated with 511 data points, from which 393 concern field measurements of biomass productivity from prunings, 8 are field measurements of biomass productivity from plantation removals, 65 mechanized collection experiences for prunings, 3 mechanized plantation removal experiences and 42 value chains, of which 10 have been characterized and studied in detail as "flagships". It should be noted that the Observatory has succeeded not only in meeting, but actually in exceeding the initial targets set in the project contract, thanks to the efforts of the uP_running project partners as well as of various external collaborators: farmers / producers involved in field measurements, various prime movers of new value chains supported by the project, etc.

In order to maintain this extensive database of experiences, CERTH plans to maintain the Observatory tool till at least the end of 2024, five years after the project duration. CERTH also commits to periodically update the database, provided that new experiences, generated after the project's end, are brought to its attention.

7 REFERENCES

1. N. Voca, N.B., et al., *Energy potential of fruit tree pruned biomass in Croatia.* Spanish Journal of Agricultural Research, 2012. **10**(2): p. 292-298.
2. Spinelli, R., N. Magagnotti, and C. Nati, *Harvesting vineyard pruning residues for energy use.* Biosystems Engineering, 2010. **105**(3): p. 316-322.
3. Spinelli, R., et al., *Integrating olive grove maintenance and energy biomass recovery with a single-pass pruning and harvesting machine.* Biomass and Bioenergy, 2011. **35**(2): p. 808-813.
4. Magagnotti, N., et al., *Technology alternatives for tapping the pruning residue resource.* Bioresource Technology, 2013. **128**: p. 697-702.
5. Spinelli, R., et al., *Production and quality of biomass fuels from mechanized collection and processing of vineyard pruning residues.* Applied Energy, 2012. **89**(1): p. 374-379.
6. Recchia, L., et al., *New shredding machine for recycling pruning residuals.* Biomass and Bioenergy, 2009. **33**(1): p. 149-154.
7. Acampora, A., et al., *Product contamination and harvesting losses from mechanized recovery of olive tree pruning residues for energy use.* Renewable Energy, 2013. **53**: p. 350-353.
8. Julio César Camarena-Tello, N.E.R.-G., José Alberto Gallegos-Infante, Rubén Francisco González-Laredo, Fabiola Eugenia Pedraza-Bucio, Pablo López-Albarrán, Rafael Herrera-Bucio,and José Guadalupe Rutiaga-Quiñones, *Chemical composition of biomass generated in the guava tree pruning* EXCLI 2015. **14**: p. 204-212.
9. EuroPruning, *Deliverable Reporting: D3.1 Mapping and analysis of the pruning biomass potential in Europe.* 2016.
10. Velázquez-Martí, B. and E. Fernández-González, *Analysis of the process of biomass harvesting with collecting-chippers fed by pick up headers in plantations of olive trees.* Biosystems Engineering, 2009. **104**(2): p. 184-190.
11. Velázquez-Martí B., F.-G.E., López-Cortés I., Callejón-Ferre A.J., *Prediction and evaluation of biomass obtained from citrus trees pruning.* Food, Agriculture and Environment, 2013. **11**: p. 1485-1491.
12. Alissa Kendall, E.M., Sonja Brodt, Weiyuan Zhu, *Life Cycle–based Assessment of Energy Use and Greenhouse Gas Emissions in Almond Production, Part I: Analytical Framework and Baseline Results.* Journal of Industrial Ecology, 2015. **19**(6): p. 1008-1018.
13. Stefania Proietti, P.S., Umberto Desideri , Francesco Zepparelli, Antonio Brunori, Luana Ilarioni, Luigi Nasini, Luca Regni, Primo Proietti, *Carbon footprint of an olive tree grove.* Applied Energy, 15 August 2014. **127**: p. 115-124.
14. Spinelli, R. and G. Picchi, *Industrial harvesting of olive tree pruning residue for energy biomass.* Bioresource Technology, 2010. **101**(2): p. 730-735.
15. R. Spinelli, R.S., N. Magagnotti, C. Nati, L. Pari, J. L. Vanneste, *RECOVERINGKIWIFRUITPRUNING RESIDUES FORBIOMASSPRODUCTION.* Transactions of the ASABE, December 2011. **55**(1): p. 1-8.
16. A. Assirelli, A.A., S. Croce, R. Spinelli, E. Santangelo, L. Pari, *Mechanized recovery of olive pruning residues: ash contamination and harvesting losses.* Journal of Agricultural Engineering, 2013. **XLIV**(s2): p. 623-626.
17. Raffaele Spinelli, N.M., Carla Nati, *Harvesting vineyard pruning residues for energy use.* Biosystems Engineering january 2010. **105**: p. 316-322.

18. Dr. Luigi Pari, I.M.C. *DEVELOPING OF A PRUNINGHARVESTING MACHINERY*. in *12th European Conference on Biomass for Energy, Industry and Climate Protection*. 17-21 June 2002. Amsterdam, The Netherlands
19. EuroPruning, *Deliverable Reporting: D5.1 Report on logistics chain and knowledge gaps of biomass.* 2016.
20. uP_running, *Deliverable Reporting: D6.3 Flagship success cases update v1* 2017.

21. Michael-Alexandros Kougioumtzis, Emmanouil Karampinis, Panagiotis Grammelis, Emmanuel Kakaras . Exploitation of olive tree prunings. Evaluation of an integrated harvesting demonstration in Central Greece, 27th European Biomass Conference and Exhibition, Lisbon 2019.
22. EuroPruning, Deliverable report D6.2, CIRCE, 2016. Results with conclusions of each demonstration (by zone and step). Available at: www.europruning.eu

23. uP_running, *Deliverable Reporting: D6.4 Flagship success cases update v2* 2019.