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The restoration of water quality in the Seman basin through sustainable practices

Convert settlements activities waste into energy supply source

keywords / water quality, energy supply, waste, sewage, MSW, biogas

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164 Abstract

Despite the fact that the Seman region is one of the most fertile areas in Albania, the human actions for the last 20 years has compromised its integrity. Existing settlements with their related activities represent a risk for the whole area, its farming potential and people's health. Preserving the remaining integrity and restoring as much as possible the environment characteristics, has to be a priority for national and regional Governments' strategies as well as for basin's inhabitants.

Restoring the water quality must be the first point to focus on. In fact the water has multiple roles in preserving the quality of life and the quality of soil; consequently of land products.

One of the factors, which is the cause for the loss of quality of the Seman water is the waste management generated by household activities. The dump of sewage and of dirty water in Seman's streams, the incorrect waste disposal practices and absence of people awareness on the problem, spread waste down the river banks with water pollution consequences.

Waste and sewage are sanitary, social and economic dangers to be afforded promptly with strong policies and new guidelines; were inhabitants could be part of these new sustainable practices. The utilization of the households' waste like resource can be a kilometer 0 element to contribute in the water quality problems solution. Anaerobic Digestion from the waste organic fraction and community sewage digester are a possible direction.

The paper investigates the possibility to introduce small scale systems in the Seman basin settlements, predicting a scenario where people are leading the Seman water quality restoration through tools which could be managed personally and which could increase the awareness about the environmental problem.

Introduction

The Seman basin is a precious natural resource for Albania. With its 286 km, including Osum and Devoll, and a drainage basin area of 5740 km², the Seman crosses the most fertile area in the country with an enormous potential. Despite this valuable source, the current situation of the basin compromises its use and its development. In the last 20 years the unorganized development of Albania has caused a rapid escalation of human activities, from housing to economical ones, with compromising environmental consequences. In this scenario the Seman

river has not been spared and today it is among the most polluted rivers in Albania (INSTAT - Ministry of Environment, 2014). From not well planned oil drilling activities, abandoned industries, not urbanized settlements, to the lack of policies related to waste collection and management, there are many causes that have heavily damaged the Seman water quality.

In the approach to Seman basin environment restoration, the population involvement and awareness can represent a crucial step towards the refurbishment of water quality, focusing the attention

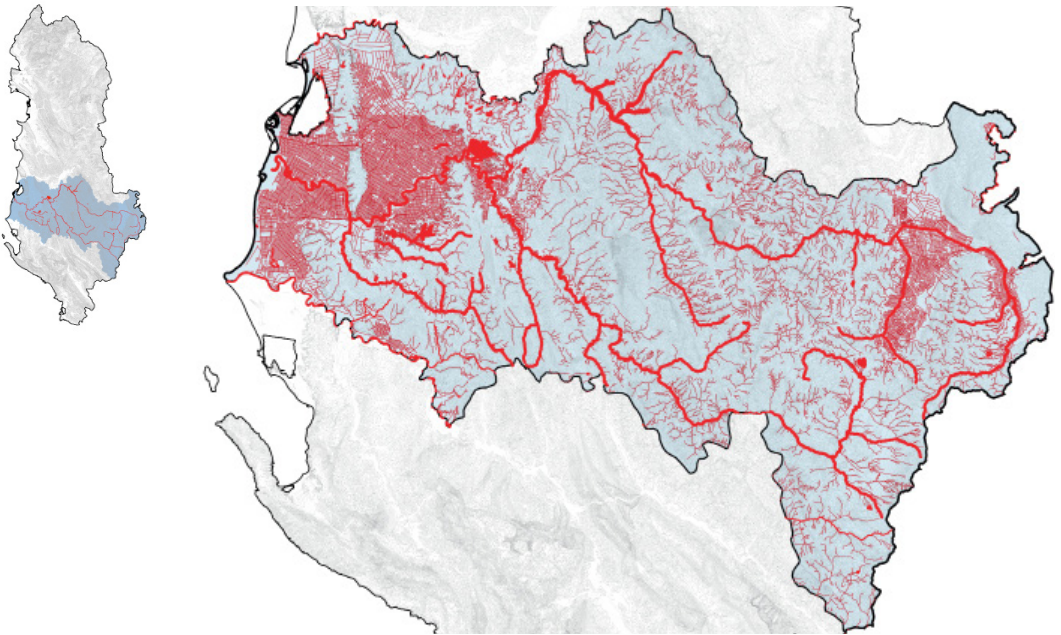


Fig1 / Seman basin placement in Albania

Fig2 / Water extension in Seman basin area. The water, in red, is a constant presence all over the area of the basin. The following figures show the contact among water, dumpsites and cities. source / GIS data from geoportal.ogis.gov.al and GIS by POLIS University

on waste problem related to human settlements in the basin. The paper investigates a possible direction which could potentially inform citizens and their role inside the natural area where they live in, through biogas utilization. Indeed, biogas from household biowaste can be an alternative solution to current waste management practices, from one of the causes of Seman pollution generated by human activities (discharge in the river), into a source with multiple merits in line with the EU principles and environmental strategies, social and economic; another step for Albania in regards of the involvement and integration in the European scenario.

The paper is developed in four parts: the first underlines the Seman river/basin problems related to human settlements; the second investigates Albania potential in the utilization of waste with energy aim; the third part is dedicated to the identified Dermenas municipality case study, focusing the attention on biogas potential in small size settlements; the last part hosts conclusion with the expected outputs and the opportunities allowed by these sustainable practices.

The household waste / a cause of Seman river damage

The process in identifying the Seman pollution causes is not simple. In fact, the length of the river, the extension of the entire basin and the diffuse presence of human settlements with the related activities, makes the scattered scenario hard to read. For this cause this work

is going to outline the relation between waste sources and the river, focusing the attention on household waste for Municipal Solid Waste and wastewater.

The Seman basin role in Albania is crucial. In fact, if its agricultural potential could be an economic resource for the entire Country, its central position (figure 1) is fundamental for the environment in the entire state. In fact, 4 out of 10 prefectures (Fier, Berat, Elbasan and Korçe), the 40% of the regional authorities in Albania, have to afford Seman policies and management, underlining the national role of the basin for the whole State.

In this scenario a relevant factor of the basin management is the extension of its water. In fact, due to an underground aquifer close to the surface, the area is filled with water from the main stream to the agricultural drains (figure2). Consequently, the water is in contact with all the activities which take place in the area: settlements and dumpsites at first.

The spread of settlements in the Seman area is a first component to take into consideration. As shown in figure 3, there are a few big size cities (Berat, Fier and Korçe), some mediums size urban centers and a diffuse presence of small city and villages. The result is a decentralization of waste production in all the analyzed area. This represents the first problem for the Seman water quality. In fact, the human presence and its daily activities produce tone of waste and sludge which need to be properly treated. Albania disordered construction development since 1992, has consigned today an ensemble

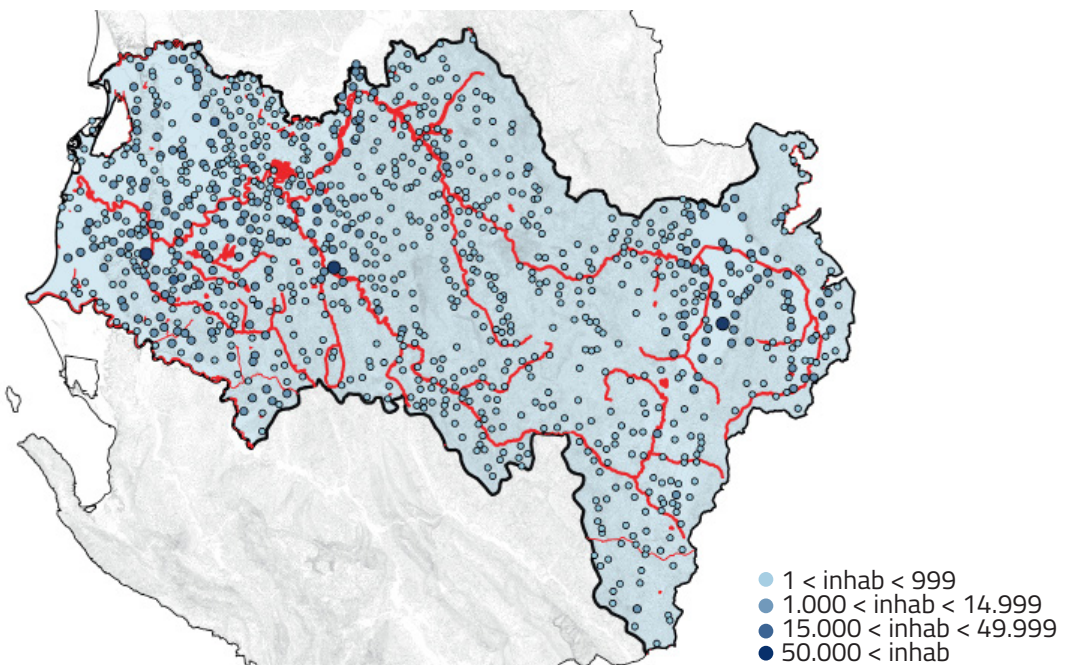


Fig3 / Settlements in the Seman basin area. The settlements are diffused in the area, especially in rural area lacking of infrastructure for wastewater collection
 source / GIS data from geoport.al.gov.al and GIS by POLIS University

of unorganized settlements poor of infrastructure and proper waste collection systems. The most affected issue stands in the sewerage system. Indeed, only the biggest cities have an adequate wastewater collection infrastructure while all the other settlements spread in the basin area, small and medium size, are poor of these systems. In addition, the total absence of wastewater treatment plant is another problem (INSTAT - Ministry of Transport and Infrastructure, 2014). As a consequence, all the sewage collected or not collected is discharged in the Seman stream and its drains, with an uninterrupted contamination of the water damaging its quality with health hazard for population, its cultivation and livestock.

In addition to sewerage, a different question could relate to household waste. Despite the quite good collection system and coverage (Fier 89%, Berat 53%, Elbasan 45% and Korçe 99%, Kodra and Milios, 2013), its disposal represent a risk for the entire area. In fact, the dumpsites are usually located close to the river (figure 4) and the recurring floods inundate the disposal areas and scatter all the waste in the water. The effects are devastating, with the entire waste collected, organic and not organic, are disseminated along the Seman streams from the dumpsites to the Seman mouth, with environmental, social and landscape consequences. In front of these problems, biogas offers an opportunity to identify a solution to challenge the few economical and education sources.

Seman basin biowaste as energy opportunity

The waste can be an economic, social and environmental source thanks to its energetic potential which is nowadays not exploited in the proper way in Albania. Indeed, the generation of Municipal Solid Waste (MSW) per inhabitant is significantly increased in Albania in the last years with 335 kg per capita in 2010, 80% more than the 2003 data (Kodra and Milios, 2013). Waste generation represents a real challenge in management practice for Albania and it is important to focus on sustainable practices which can decrease the MSW quantity disposed in dumpsites. In this scenario the utilization of biodegradable part of MSW is a precious opportunity. In fact, the organic fraction in Albania average of MSW is the 47,63% of the waste stream, about 160 kg per capita per year, where the whole biodegradable part is up to 208 kg per capita per year, including wood, paper and cardboard (Kodra and Milios, 2013). Therefore, the 62,3% fraction of MSW is biodegradable and it is considered as a Renewable Energy Source, not used in Albania. In fact, the high percentage of MSW's organic waste is either recycled or composted without any prevention from being disposed in landfills and consequently the natural organic waste biodegradation in methane (CH₄) is emitted in atmosphere from landfill sites increasing GHG emission. The absence of strategies for the utilization of CH₄ in Albania from organic waste is today an economical and energy loss.

Surely its utilization depends on national/local strategies and the related

1. Fier
2. Dermenas
3. Levan
4. Topoje-Seman
5. Roskovec
6. Patos
7. Berat
8. Urë Vajgurore
9. Kuçovë
10. Çorovodë
11. Poličan
12. Bilišt
13. Mborje
14. Korçë

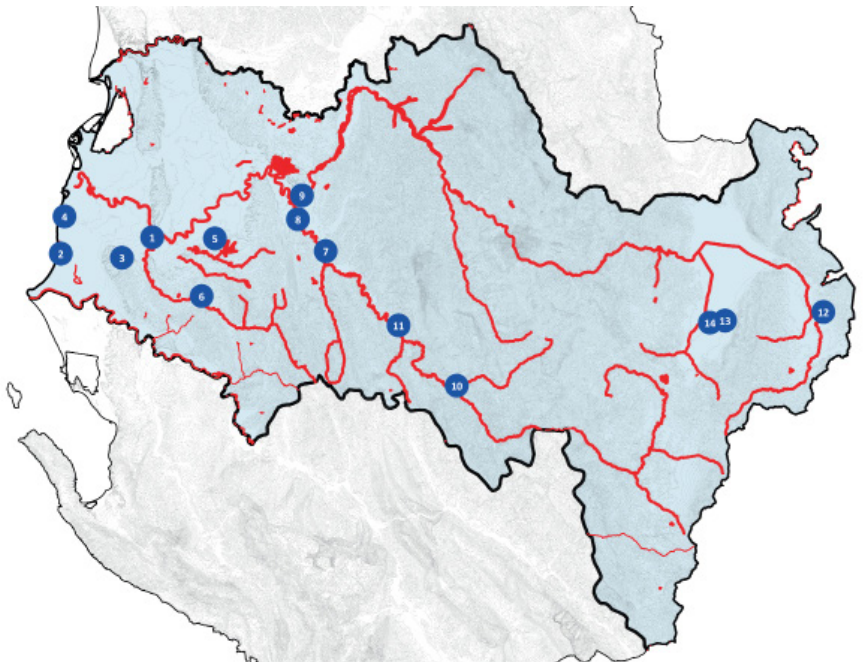


Fig4 / Official dumpsites close to Seman river. The recurring floods inundate the waste disposal sites and cause the waste scattering down the Seman stream
 source / GIS data from geoport.al and GIS by POLIS University

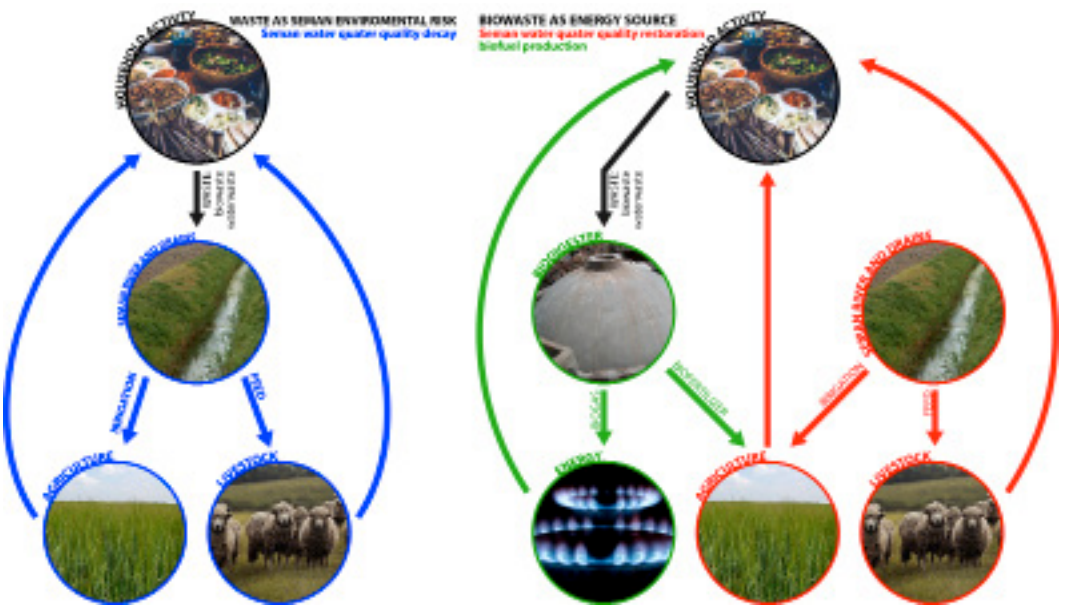


Fig5 / The change of the chain of waste in Seman basin. Waste becomes a new resource for the basin offering a sustainable opportunity to improve agriculture quality, livestock feeding and energy source
 source / drawing by the author

policies. The definition of good practices to decrease waste production and collect separately waste components is fundamental for the management actions. The waste governance has to address new sustainable ways in order to achieve waste management targets with advantages for the population, decreasing the costs, and enhance waste companies to use recyclable waste separators at the origin. In this condition, the exploitation of organic fraction through biowaste is a possibility. Instead of keeping on the creation of landfills as predicted by the National Waste Strategy and the National

Waste Management Plan 2010-2025, the producers their selves can be responsible of the part regarding management waste being involved as a matrix of the whole waste chain. Improve population's capacity building can allow in improving sustainable and environmental awareness, aiming in recycling/composting 55% of municipal waste by 2020 and reclamation energy from 15% of municipal waste by 2025. The spread of these new practices could enhance a shift from the current absolute reliance on land filling to population involvement in recycling, composting, and achieving energy targets.

In the same way another pollution element in Seman River as wastewater can become a source, answering to the limited sewerage system and the absence of treatment plant in Seman area. While major municipalities should predict for wastewater plants findings the needed funds, for the hundreds of spread villages funds are hard to find. Differently from the urban context, for rural settlement it is possible to propose an alternative solution for waste water. In fact, considering as the major part of Seman basin's population (Berat 54,39%, Elbasan 59,95%, Fier 57,94% and Korçe 59,50% INSTAT, 2016) live in an extended rural area poor of infrastructure whose realization is difficult to imagine for economic issues. Despite national and county authorities have not the adapt resources to realize sewerage systems and wastewater plants, thus it is seen as an important task of thinking about alternative solution to avoid the sludge dispersion in Seman water streams and consequently in the agricultural fields. The creation of displaced wastewater collectors localized close to small village aimed to the production of biogas, can represent an interesting and spreading solution.

In addition to the biogas production as energy source, the digestion of biowaste produces also a biofertilizer which can be a natural substitute to the chemical fertilizer diffused today. Its utilization increases the fertility of the land and it can be directly used by the citizens who will manage the digester, sold in the market, increasing the family available incomes.

The appliance of these directions could allow in transforming two pollution causes from an environmental problem in a sustainable solution (figure 5). In the next paragraph the case study provides an understanding of the potential of this source and consequently how could it contribute in the prevention of water quality.

An estimation of biogas potential / the case study of Dërmenas

The municipality of Dërmenas is one of the 17 municipalities of the Fier prefecture. It is located in the most productive area of Seman and it is characterized by a grid of drains which conduct water in the whole area. The population is 11.662 (GIS data) and it host 11 villages with Dërmenas which is the most important one. This municipality has been chosen as a general example of small size village to test biogas digester feasibility.

The table 1 shows the potential of biogas of each village. The choice has

been considering not all the potential of biowaste, but only 80kg/year for capita, only 50% of the full potential as previously estimated. The reason of this choice stands in the need to develop a building capacity for citizens, where this threshold can be considered an easy target to be achieved in a short time. The component of methane inside biogas is equivalent to 65%.

Concerning the wastewater, the existing literature, considers 0,5kg/day per capita as a good approximation of sludge, which is 182, 5 kg per year with a percentage of methane around 68% of biogas volume. The result is a total potential biogas production of 154.759, equal of 104.544 Nm³ of CH₄, a yearly energy source today dispersed.

Two different solutions have been hypothesized for biogas utilization. Table 2, the solution has been found in a CHP generator operative for 7200h/yr with a heat performance of 47% and an electricity performance of 39%. Excluding the Krygjatë village the one with less population, the villages assure a good result with the opportunity to install cogeneration systems.

The second use proposed is household cooking. The calculation presented in table 3, show how many people can be served, village by village, considering an average household type of 3 people, based on Census 2011. The result is meaningful: almost the 30% of population can be served with the opportunity to eliminate the conventional cooking methods, especially stoves or firewood, strongly air polluted.

Conclusions

The solutions for water quality improvement can be more than one, but a bottom-up approach can lead to a spread success; the results are multiple.

Firstly, there is a medium-long term environment effect which allows an increase of water quality. Indeed, a huge diffusion of village biogas systems can support the Seman decontamination of the water through the exploitation of biowaste inside basin's villages. The positive consequences of this process is the decrease of the waste landfill, with a reduction of the space aimed for disposal, and a diminution of the current health risk represented by dumpsites and their scattering during floods. The effects are an improvement of Seman water quality for its daily activity uses, such as drinking or irrigation, and a reduction of social cost for waste management as a consequence

Village	People (inh)	Type of waste	Inhabitant Matter (kg/inh/yr)	Total Matter (t/a)	Organic fraction (t _{sw} /a)	Biogas (Nm ³)	CH ₄ (Nm ³)	CH ₄ total (Nm ³ /village)
Dermenas	1.847	OFMSW	80	148	38	20900	14.212	16.610
		Waste water	182,50	337	17	3689	2.398	
Fushë	860	OFMSW	80	69	18	9900	6.732	7.860
		Waste water	182,50	157	8	1736	1.128	
Sulaj	614	OFMSW	80	49	13	7150	4.862	5.708
		Waste water	182,50	112	6	1302	846	
Hoxharë	668	OFMSW	80	53	14	7700	5.236	6.082
		Waste water	182,50	122	6	1302	846	
Havaleas	540	OFMSW	80	43	11	6050	4.114	4.819
		Waste water	182,50	99	5	1085	705	
Krygjatë	120	OFMSW	80	10	2	1100	748	889
		Waste water	182,50	22	1	217	141	
Pojan	1472	OFMSW	80	118	30	16500	11.220	13.054
		Waste water	182,50	269	13	2821	1.834	
Povelçe	1066	OFMSW	80	85	22	12100	8.228	9.639
		Waste water	182,50	195	10	2170	1.411	
Darzezë	1406	OFMSW	80	112	29	15950	10.846	12.680
		Waste water	182,50	257	13	2821	1.834	
Radostinë	1867	OFMSW	80	149	38	20900	14.212	16.610
		Waste water	182,50	341	17	3689	2.398	
Baltëz	1202	OFMSW	80	96	25	13750	9.350	10.902
		Waste water	182,50	219	11	2387	1.552	
TOTAL	11662					155.219	104.852	

Tab 1 / Hypothesis of production of biogas in Dërmenas Municipality. The 11 villages produce different biogas quantity in relation with their population source / table by the author

Village	CH4 total (Nm3/village)	Thermic Energy installed (kWt)	Electric Energy installed (kWe)
Dermenas	16.558	11	9
Fushë	7.710	5	4
Sulaj	5.504	4	3
Hoxharë	5.988	4	3
Havaleas	4.841	3	3
Krygjatë	1.076	1	1
Pojan	13.196	8	7
Povelçe	9.556	6	5
Darzezë	12.604	8	7
Radostinë	16.737	11	9
Baltëz	10.775	7	6
TOTAL	104.544	67	55

Tab2 / Hypothesis of Biogas utilization through CHP generator source / table by the author

Village	CH4 total (Nm3/village)	cooking gas 3inhs (Nm ³ /yr)	people served
Dermenas	16.558	90	552
Fushë	7.710	90	257
Sulaj	5.504	90	183
Hoxharë	5.988	90	200
Havaleas	4.841	90	161
Krygjatë	1.076	90	36
Pojan	13.196	90	440
Povelçe	9.556	90	319
Darzezë	12.604	90	420
Radostinë	16.737	90	558
Baltëz	10.775	90	359
TOTAL	104.544		

Tab3 / Hypothesis of Biogas utilization through cooking utilization source / table by the author

of flooding events.

Moreover, there is also an energetic result with the methane produced by biodegradation suitable in supplying settlements' (houses) with biogas usable for cooking as for energy co-generation, not dispersing its energy potential in atmosphere.

Another outcome is the social aspect. The solution proposed can contribute in the creation of a capacity building of the population through the exploitation of their waste as source. The citizen's awareness in biogas zero kilometer energy sources could be also improved by using other settlements' activities as agricultural waste, livestock manure, green waste from natural area along the river bank.

Biogas has today an underestimated potential, but a technology and an environmental impact, related to expected emissions, which is deeply known with remarkable opportunities in rural applications (Wellinger, Murph, Baxter, 2013). The existing know how offers a sustainable instrument which can contribute strongly in the decontamination of Seman water quality, with waste which turns into a source to exploit, obtaining social, economic and environmental positive results.

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*Fig / Rural landscape from the Apolonia archeological site
source / Vezir Muharremaj*