Should carbon issues modify agri-environmental support to mountain grazing? A case study in the Italian Alps

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Abstract—**The increasing importance of the carbon sequestration issue calls the researchers to investigate if the agri-environmental support (AES) to extensive mountain grazing granted under Regulations 2078/92, 1257/99 and 1698/2005 is still efficient. AES may have contributed to the maintenance of low carbon stocks in extensive grazing areas, which might otherwise have been abandoned and revegetated by species that assist carbon sequestration.**

We evaluate benefits and costs of supporting the maintenance of pastureland through cattle grazing in an Italian Alpine pasture for 2004. We focus on three non-commodity outputs of Alpine grazing -landscape-recreation amenities, carbon sequestration and contribution to economic vitality of the area - and three groups of agents: visitors, local community and EU households.

The efficiency of supporting mountain grazing is demonstrated by a net benefit of € 228,613. Landscape-recreational benefits are the key variable, as their value (€ 205,377) is large enough to justify the grazing activity and the related support. The value of carbon sequestration achievable with reforestation (€ 62,491) could not compensate the loss in tourism benefits. Net beneficiaries of the agri-environmental policy are not the farmers but the visitors and the local community. Transforming of the intangible goods (both landscape – recreational amenities and carbon sequestration) into tangible ones would favour the local community.

The overall convenience of supporting the maintenance of Alpine pastureland through cattle grazing depends on the number and the types of benefits and costs we consider. When a complete evaluation of all the benefit and cost flows is impossible or when an aspect, previously considered as irrelevant, suddenly increases its importance (such in the case of carbon sequestration), an approach inspired by the precautionary principle is absolutely necessary and wise.

Keywords — **agri-environmental support, mountain grazing, carbon sequestration**

I. INTRODUCTION

One of the new important challenges for the European agri-food sector is its contribution to combating climate change. Article 3.4 of the Kyoto Protocol (1998) (KP) and Marrakesh Accords (2001) acknowledge the potential contribution of agricultural soils to carbon sequestration by including forest management, cropland management, grazing land management and revegetation into the so-called Land Use Change and Forestry activities.

The inclusion of grazing land management put the spotlight on the about 55 million ha of grassland registered in the EU15 in 2000 [1] whose capacity to act as carbon sink is still under investigation [2]. On the other hand, "natural reforestation" of semi-natural grassland (accepted as afforestation or reforestation under article 3.3 of KP) is generally considered to have positive effects on the carbon balance due to biomass accumulation [3].

The new carbon issue calls the researchers to investigate if the agri-environmental support (AES) to extensive mountain grazing granted under Regulation 2078/92 and reconfirmed under the second pillar of the Cap (Regulations 1257/99 and 1698/2005) is still efficient from a social point of view.

These subsidy payments, plus the compensatory allowance, have represented a significant part of mountain breeders' net income, and have proved to be an important factor in the successful maintenance of mountain farming structures and thus of the traditional cultivated landscape [4]. On the other hand, local AES assessments questioned about their environmental effectiveness and/or the impacts at the local level [5]. Even the Working Group of the European Climate Change program [6] stated AES may have contributed to the maintenance of lower than natural carbon stocks in extensive grazing areas, which might otherwise

have been abandoned and revegetated by species that assist carbon sequestration.

In order to evaluate if carbon issue contributes to question the efficiency of agri-environmental support, we framed the multifunctional role of mountain grazing and estimated some utility and disutility flows associated with it by working on a case study - an Alpine pasture situated in the province of Trento, in the North East of Italy.

II. LANDSCAPE-RECREATIONAL AMENITIES, CARBON SEQUESTRATION AND CONTRIBUTION TO ECONOMIC VITALITY

Grazed mountain pasturelands have always produced a series of non commodity outputs (NCOs) that can be classified into two broad groups: environmental and socio-economic functions. Among environmental functions there are landscape and recreational amenities creation, prevention of forest fire advancement and parasite attacks, biodiversity conservation, soil erosion protection and snow cover stabilisation, flood protection, sustenance of beneficial ecological processes, carbon sequestration [7] [1] [8]. Less often stressed in the literature are NCOs of a socio-economic nature such as the historical-cultural function and the contribution to the economic vitality of the area through both the capacity of attracting tourists and the possibility to monetarily valorise the organoleptic and nutritional properties of milk and meat produced at a high altitude.

Among these functions, landscape amenities creation is considered the most prominent non-agricultural use made of grassland [7] and has been deeply investigated in the literature, whereas carbon sequestration is of increasing importance into the current debate, but the estimation is still at its beginning. Therefore we decided to deal mainly with these two functions, adding a rough estimation of the contribution to the economic vitality of the local community, assuming other NCOs remain the same.

Landscape-recreational amenities (Am) are impure public goods since they are partially nonrival and may be excludable. The beneficiaries are the visitors which may be local people or not. Carbon sequestration (Cs) is a pure public good, with no rivalry and no excludability and its transnational nature allows us to hypothesize EU households as beneficiaries. The contribution to the economic vitality (Ev) of the area generated by the visitors' spending during their stay is clearly a benefit for the local community.

The agents actively involved in the decision process concerning pasture utilization and therefore in determining the level of Am, Cs and Ev and the benefits distribution are essentially three: the farmer, the local policy maker and the local authority.

If we consider only private costs and revenues, the farmer does not have any economic rationale for using the mountain pasture, as costs would significantly increase because of additional management costs (for herdsman, feed supplement and rent) and revenues might decrease due to yield reduction. Public subsidies become therefore the key factor: only if income including subsidies is expected to cover costs, the farmer will decide to transfer cattle on pasture.

The local policy maker is committed to decide which measures to activate under the Rural Development Policy (RDP) (subsidies for grazing and/or subsidies for infrastructural investments). Since subsidies for grazing under AES should be based on the regional average of cost differentials and production reductions, the possibility of extra-profits for farmers would be almost inexistent or limited to the few most efficient ones.

A third agent is fundamental in the decision process when pastureland is public owned: it is the local authority who decides whether renting the pasture or allowing afforestation and the mechanisms to define the rent amount (i.e. auctions). When renting the pasture, the local authority states a preference for visitors and local community members instead of for carbon beneficiaries, implicitly determining a prevalence of local on international benefits.

In order to complete the picture, we have to consider that the decision to rent the pasture entails some consequences in term of additional costs to be paid by the local community. As landowner, the local authority - even if supported by subsidies under the RDP - has to partially bear investment costs for increasing the productivity of the pasture and for infrastructures maintenance. Local authority is also bound to supply other necessary services (road maintenance, garbage removal, etc.) which turn out to improve the recreational experience of visitors. These

social costs, net of revenues such as admission fees, have to be taken into account when the net social benefit is calculated.

The net social benefit associated with the maintenance of mountain grazing can be defined as the difference between the benefits flows and the direct (subsidies) and indirect costs associated with the policy under examination.

III. CASE STUDY

A. Site description

The Alpine pasture of Campogrosso (about 500 hectares between 1,300 and 1,500 metres ASL) has been used for the summer grazing of dairy cows and heifers for centuries. The landowner is Vallarsa Municipality (Trento province) who rents the pasture by auction to farmers. As it is situated under the tree-line, lack of grazing would bring natural reforestation. From 50,000 to 56,000 people visit the pasture each summer. Two roads reach the area: one from Veneto and one from Trentino. The latter can be transited by car before 8.00 a.m. only by herdsmen and residents of Vallarsa, paying a 1 € road toll.

B. Landscape-recreational benefits

The landscape-recreational benefits of Campogrosso pasture have been estimated using the Contingent Valuation (CV) method. CV is actually recognized as the most suitable for evaluating landscape as a whole [9] and ex-ante [10]. We specifically evaluated visitors willingness to pay (WTP) for avoiding natural reforestation of the pasture. In fact, the hypothetical market explained that herdsmen would abandon the summer pasture due to reduction of European Union subsidies and shrubs and dry scrub would rapidly invade the area. Respondents were reminded about an adjacent area where this dynamics was clearly observable. To avoid the abandonment breeders would be supported through the payment of an entry ticket. 512 visitors were interviewed during the summer of 1998 using a double bounded format [11]. The response rate was 94%. Values have been updated to 2004 using ISTAT - National Institute of Statistics – indexes.

Table 1 Landscape-recreational value of Campogrosso pasture (in 2004 €)

	Wtp	Annual value	Annual value/ha
Median (*)	3.59	179,431	358.86
Mean (*)	4.11	205,377	410.75

(*) Calculated at parameters

The average willingness to pay an entry ticket was € 4.11. Since the number of tourists interested in the site was estimate to be about 50,000 (lower bound), the annual landscape-recreational value of Campogrosso pasture for 2004 was equal to € 205,377 and the annual value per hectare was € 410.75.

C. Carbon sequestration

Despite the increasing number of scientific studies aiming at measuring the carbon sequestration capacity of different ecosystems (forest, cropland, and grassland), information on carbon dynamics in grassland is still scarce, even because carbon is mainly accumulated below ground. Considering that grasslands of more than 20 years no longer act as carbon sinks [12], we hypothesized that the Campogrosso plateau did not absorb carbon. In any case, small carbon stock changes were not accountable for Kyoto commitment given the net-net accounting method which imposes to calculate credits/debits against the 1990 baseline.

On the contrary, when we considered the natural afforestation of the area which presents good climatic and territorial characteristics, notwithstanding the greater uncertainty about soil carbon accumulation [12], we could hypothesize a successful natural afforestation in terms of carbon balance. Lack of data forced us to limit the estimation exercise to the carbon content in the above ground biomass, that is in only one out of the five pools (aboveground and belowground biomass, dead wood, litter, soil organic matter). Using the first data released by the Italian Forest Inventory [14], in the period 1995-2000 the average increase of carbon stock in Trentino forest was equal to 1.56 Mg ha^{-1}. Converting this quantity of carbon in tonne of CO_2 equivalent, we obtained 5.72 Mg ha^{-1} of CO_2 eq. annually sequestered by Trentino forests.

Two options were available for monetizing the change in carbon sequestration: a) the market price of carbon or b) the social cost of carbon (SSC).

a) Since the European Union Emission Trading Scheme (Directive 87/2003) commenced operation in January 2005, we had to resort to international market values, more precisely to the price per tonne of CO_2 eq. calculated for the Joint Implementation and Clean Development Mechanism projects in the first five months of 2004 [15]. This was determined at 5.52 \$/tCO_2 eq., equal to 4.77 €/tCO_2 eq.

b) When we consider that carbon sequestered contributes to limit the negative consequences of climate change, SSC should be used. This concept, increasingly used in the estimation literature, is highly questioned because of great estimates' variability [16]. Indeed, Tol's review [16] of 103 estimates reported a wide range of values: the mode at \$0.5/t CO_2 eq., the median at \$3.8/t CO_2 eq., the mean at \$25.3/t CO_2 eq., the upper bound at \$95.4/t CO_2 eq. Converting the average value for the same exchange rate used in [15], we obtained 21,85 €/tCO_2 eq. This value is only slightly higher than the average price (20 €/tCO_2 eq) utilised in similar evaluation exercises.

We therefore decided to use the average SSC value to attach a value to the carbon sequestration loss due to pasture maintenance. This benefits loss amounts to 124.98 € ha^{-1} and to an overall value of € 62,491.

D. Contribution to economic vitality

As tourists usually spend money in hotels, camping, restaurants and shops, the effect of tourist flows on local economy has been estimated accounting only for non-local tourists. Since we found 2.4% of non-local visitors (all Italians) in our sample, we estimated 1,200 tourists in the summer 2004. The lack of data on daily tourist expenditure for summer 2004 forced us to use 2005 data [17]. Given that tourists presumably made a multi-purpose trip and remained only one day on Campogrosso pasture, we imputed only one day expenditure (€ 72.3). This brought us to a rough estimate of the impact on the local economy of € 86,760. Other revenues the local community can indirectly benefit from were land rent, road toll and fines.

IV. DISCUSSION

To investigate the relevance of the carbon sequestration issue in agri-environmental policies we approached multifunctionality through a cost-benefit analysis. Table 2 summarizes benefits of the pasture maintenance policy as estimated in the previous sections and costs borne by the local administrations (directly collected from the Province of Trento and the Municipality of Vallarsa). The cost-benefit table is formatted so as to incorporate and highlight financial transfers and the distributional impact of the costs and benefits across stakeholders [18].

Table 2 Efficiency of supporting Campogrosso pasture

	Beneficiaries			
Benefits (+)/Costs (-) (in 2004 €)	Local community	Visitors	EU households	Σ
Landscape-recreational		205377		205377
Tourists expenditure	86760			86760
Land rent	14692			14692
Road toll	827			827
Fines	1460			1460
Carbon sequestration			-62491	-62491
Grazing premium (a)			-36000	-36000
Depreciation/maint. of buildings and roads:				
- local contribution	-10388			-10388
- EU contributions (b)			-41552	-41552
Road surveillance	-8480			-8480
Waste removal	-4672			-4672
Net benefit	127279		-104043	228613

(a) Under action 6.2.2. of the RDP 2000-2006 the annual premium is up to a maximum of 72 Euro/hectare.
(b) Under action 15.2 of the RDP 2000-2006 for the renovation of cattle shed and water provision.

The efficiency of supporting the maintenance of Alpine pastureland is demonstrated by a net benefit of € 228,613. Net beneficiaries of the policy are visitors and the local community, whereas EU households bear the costs. Nevertheless, both landscape-recreational creation and carbon sequestration are goods of intangible nature. Visitors' benefits could be partially or totally captured by the local community through the introduction of an entry ticket. On the other hand, the reforestation of the pasture will entail the transformation of an intangible cost for EU households into a tangible benefit, if carbon credit is sold on the market. In fact, the prospect of creating a National Register for Agro-forestry Sinks and the consequent emission of carbon credits [19] would give the

landowners the possibility to be remunerated for the carbon sequestered. As the pastureland is public owned, revenues would be gained by the local community. In this perspective the variable factor is the carbon price. In our case study both the market price and the social cost of carbon are not big enough to justify the reforestation of the Campogrosso pasture, even if we take the highest market price of CO_2 - that is 29.75 € registered in April 2006.

V. CONCLUSION

Agri-environmental policies are efficient if the benefits produced outweigh the overall costs. The multifunctional character of agricultural productions makes this evaluation a difficult task, especially in complex ecosystems as mountain areas are.

We evaluated social benefits and costs of supporting the maintenance of mountain pastureland through cattle grazing in an Italian Alpine pasture. The efficiency of supporting mountain grazing pasture is demonstrated by a net benefit of € 228,613. Landscape-recreational benefits are the key variable, as their value is large enough to economically justify the grazing. Estimated benefits associated with carbon sequestration expected from reforestation cannot compensate the loss in tourism benefits at any current or past carbon price. The rough estimate of the economic contribution to the local economy highlights the importance of this aspect, which is often neglected in the literature. End beneficiaries of supporting mountain grazing are not the farmers but the visitors and the local community, whereas EU households bear the costs of policies and of carbon sequestration loss.

The overall convenience of supporting the maintenance of Alpine pastureland through cattle grazing obviously depends on the number and the types of benefits and costs we considered. Given the impossibility to perform a complete evaluation of all the utility and cost flows, our analysis and conclusions cannot be considered exhaustive. Nevertheless, they clearly highlight the advisability to adopt an approach inspired by the precautionary principle when a comprehensive evaluation is impracticable or when an aspect, previously considered as irrelevant, suddenly increases its importance, such in the case of carbon sequestration.

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