The Economic value

Critical Ecosystem Partnership Fund(CEPF)

Shouf Biosphere Reserve

January 2015

The natural environment provides the foundations of our society and our economy. It not only makes life possible on Earth but it makes it worth living.

This is the first ecosystem services evaluation conducted in Lebanon, under the leadership of the Al-Shouf Cedar Reserve.

The study should be interpreted as a foundation for future studies. It is hoped that it will inspire similar assessments and evaluations of Lebanon's ecosystem services. Those studies can in turn guide and influence policy making that will favor the long-term conservation of the country's unique habitats and ecosystems.

Project title:
Enhancing Sustainable Livelihood and Promoting Community Management of Shouf Biosphere Reserve

Prepared by: Ecodit – Karim El-Jisr, Osama Abou Rayan, Capricia Chabarekh
Coordinator: Nizar Hani
Reviewed by: Faisal Abu-Izzeddin
Administration: Samer Zebian, Kamal Abou Assi
TORs prepared by: Aniol Esteban – IUCN
Photos by: Project team
Design & layout:VISUAL IDENTITY

Funded By

CRITICAL ECOSYSTEM PARTNERSHIP FUND

Compiled by

ECODIT

In cooperation with

IUCN

TABLE OF CONTENTS

EXECUTIVE SUMMARY

I. EXECUTIVE SUMMARY

The natural environment provides the foundations of our society and our economy. It not only makes life possible on Earth but it makes it worth living. Unfortunately, our economic system fails to recognize most of the services that nature provides to humans, as well as the intrinsic value it already has "per se". This lack of awareness about how nature contributes to our collective and individual wellbeing is one of the reasons why we are failing to protect the natural systems we depend on. Revealing the economic value of these systems is a helpful exercise which can help raise awareness; engage the public; and encourage policy action to ensure these systems are protected.

The overarching goal of this study was to describe, in preliminary terms, the economic value of the Shouf Biosphere Reserve (SBR) - the largest Reserve in Lebanon. The study was conducted in 2014 in close coordination with the SBR team. The study was structured according to three phases:

1. Identification of key ecosystem services,
2. Data collection, and
3. Describing most relevant services in monetary terms.

Like most nature valuation studies, rather than attempting to value all ecosystem services flowing from the reserve, we focused on the most significant ones. Following several visits to the SBR and meetings with the staff of the reserve, it was agreed that the study would focus on describing the value of the following services:

- Carbon sequestration,
- Fuel provision (briquettes production),
- Water provision,
- Food provision,
- Tourism, and
- Cultural services and patrimonial value.

Some of these (e.g., food, water, recreation, briquettes) have economic activity linked to them which can help us value the corresponding ecosystem service. The study compiled local data to estimate the value of the economic activity associated with those services. Gross revenues and employment – not monetized - are used to value the ecosystem services related to food, water and fuel provision as well as leisure activity. The value of Carbon sequestration services provided by the Reserve is estimated using a previous estimate about C sequestration potential and one of the proxies for the price of Carbon.

Cultural services could not be described in monetary terms and were therefore only described qualitatively. For example, what is the patrimonial value of the Lebanese cedar? Also, the contribution of the SBR to enhancing Lebanon's image is priceless but could not be valued for the same reasons.

Based on the above analysis and limitations, the results show that the **economic benefits generated by Shouf Biosphere Reserve every year are in the range of 16.7 to 21.3 million US dollars.** Most of these benefits derive from water services including grid water quality and bottled water. The value of Carbon sequestration services and production of biomass (i.e., briquette) is also significant. **Tourism injects annually an additional $700,000 in the region and supports local employment equivalent to circa 100 jobs.** Whereas some of the

previous ecosystem services are intangible, the economic value of tourism activities in the SBR is tangible, and growing.

The estimated value of SBR services is summarized below.

Ecosystem service	Value ($/year)
Carbon	
C sequestration	$860,000
Seed collection for nurseries	$50,000
Biomass provision	$200,000- $1,000,000
Water provision	
Grid water (Barouk and Safa)	$8,437,500 - $11,250,000
Grid water (eastern district)	$785,250 - $1,047,000
Water bottling industry	$2,640,000 - $3,360,000
Ecological benefits of Ammiq wetland	$600,000
Hydropower	$1,300,000
Food provision	
Rangelands for animal production	$600,000
Rural products (SBR label)	$130,000
Incremental honey production	$450,000
Tourism	
Tourism entrance fees	$186,000
Guesthouse accommodation	$79,000
Conventional restaurants	$247,500
Tawlet Ammiq (Eco-restaurant)	$200,000
Cultural services	Priceless
Total	$16,765,250 - $21,359,500

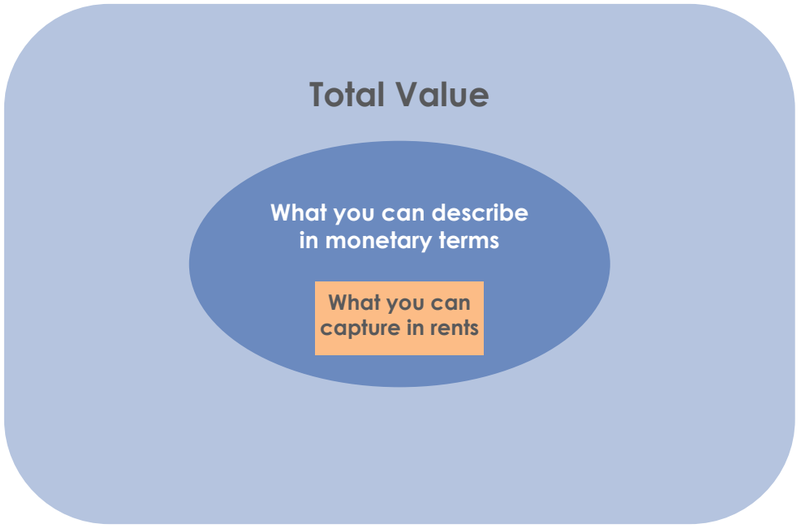
Most of the economic benefits described above can be attributed to the presence of the SBR, either in whole or in part. For example, the Reserve plays a key role in securing the supply of waterto a local population of at least 116,000 and maintaining water quality in the region; as such, one can argue that those benefits would not be at the same level if the SBR was not there. Tourism related expenditure can also be attributed to the presence of the SBR because if it was absent, spontaneous and unregulated tourism would eventually deplete or degrade the natural resource. Likewise, Carbon sequestration and the potential for biomass production are only possible thanks to the sustainable management guaranteed by the presence of the Reserve and its management team.

However it is important to emphasize that the study did not look into detail at attribution issues and did not attempt to answer a difficult question:how much of this value would still be there if the reserve did not exist? This is an area that requires further research and discussion because the process of determining attribution is not easy or straight-forward and is often based on personal judgment.Although the attribution element is not fully analysed, it is worth mentioning that many goods and services provided by SBR have not been valued in this study (see figure).

It is not possible to describe the entire value of the SBR in monetary terms. This study only describes part of the middle box (what you can capture in rents) and part of the dark blue box (what you can describe in monetary terms), but it does not even go into the light blue box. Therefore, when interpreting the results presented in this study, it is important to remember that they only reflect one fraction of the total value of services provided by the SBR.

Despite these limitations, the economic value of the SBR (about $19 million on average) vastly exceeds the operational budget of the SBR team (about $1 million including investment and maintenance), by a factor of 20 to 1. Stated simply, every $1 invested in the SBR returns $20 of benefits to the region and the people.

Nature is priceless and by extension the SBR is priceless too.



Source: New Economics Foundation adapted from TEEB[1]

[1] *The Economics of Ecosystems and Biodiversity (TEEB)*

ا.ا ملخـص تنفيـذي

توفر بيئتنا أسس مجتمعنا واقتصادنا. ليس فقط في جعل الحياة ممكنة على الارض لا بل في جعلها جديرة بان تعاش.ولكن للاسف، لقد فشل نظامنا الاقتصادي في ادراك معظم الخدمات التي يمكن ان توفرها الطبيعة للناس وكذلك ادراك قيمتها الجوهرية. هذا النقص في الوعي حول كيفية مساهمة الطبيعة في حفظ سلامتنا الجماعية والفرديةهو من احد اسباب فشلنا في حماية النظم الطبيعية التي نعتمد عليها. الكشف عن القيمة الاقتصادية لهذه النظم هونشاط مفيد لرفع مستوى الوعي، واشراك الناس، و تشجيع العمل القانونيلضمان حماية هذه النظم.

الهدف الرئيسي من هذه الدراسة هو من الناحية المبدئية، وصف القيمة الاقتصادية لمحمية الشوف المحيط الحيوي التي تعتبر "أكبر محمية طبيعية في لبنان". لقد اجريت هذه الدراسة عام 2014 ضمن تنسيق وثيق مع فريق عمل المحمية. و قد نظمت الدراسة وفقًا لثلاث مراحل:

1. التعرف على خدمات النظم الإيكولوجية الأساسية
2. جمع البيانات
3 . وصف الخدمات الأكثر أهمية من الناحية المالية

كمعظم الدراسات التقييمية للطبيعة، بدلا من محاولة تقييم جميع خدمات النظم الإيكولوجية التي تؤمنها المحمية، تمّ التركيز على الخدمات الاكثر أهمية. بعد زيارة المحمية عدة مرات وعقد لقاءات مع موظفيها وكذلك استشارة الخبراء في هذا المجال، تمّ الاتفاق على ان تركز الدراسة على وصف قيمة الخدمات التالية:

- احتباس الكربون
- توفير الكتلة الحيوية
- توفير المياه
- توفير الغذاء
- السياحة
- خدمات ذات قيمة ثقافية وتراثية

بعض هذه الخدمات (مثل الغذاء، الماء، الترفيه، والكتلة الحيوية) ذات صلة بالنشاط الاقتصادي والتي يمكنها أن تساعدنا في تقدير قيمة خدمات النظم الإيكولوجية. الدراسة جمعت البيانات المحلية لتقدير قيمة النشاط الاقتصادي المرتبط بتلك الخدمات.

إجمالي الإيرادات والتوظيف-الغيرمحسوبة نقديًا- استخدمت لتقييم خدمات النظم الإيكولوجية المتعلقة بالمنتجات المحلية والمياه وتوفير الكتلة الحيوية وكذلك النشاط الترفيهي. قيمة خدمة احتباس الكربون في المحمية تحتسب باستخدام التقديرات السابقة حول إمكانات احتباس الكربون .

لا يمكن وصف الخدمات الثقافية من الناحية النقدية، وبالتالي وصفت فقط نوعيًا. على سبيل المثال، ما هي القيمة التراثية للارز اللبناني؟ وكذلك، لا يمكن تقدير مساهمة محمية الشوف المحيط الحيويكمّاً في تعزيز صورة لبنان للأسباب نفسها.

بناءًا على التحليل والقيود المذكورة أعلاه، لقد بينت النتائج أن الفوائد الاقتصادية التي تؤمنها محمية الشوف المحيط الحيوي كل عام هي في متوسط 19 مليون دولار امريكى. معظم هذه الفوائد الاقتصادية مستمدة من خدمات المياه بما في ذلك نوعية المياه، شبكات المياه، والمياه المعبأة. قيمة خدمات احتباس الكربون وإنتاج الكتل الحيوية أيضا تشكل نسبة مهمة.

كما تؤمن السياحة سنويًا مبلغًا إضافيًا يقدر ب 700,000$ في المنطقة وهي تشكل دعمًا لليد العاملة المحلية، أي ما يعادل حوالي 100 فرصة عمل. في حين أن بعض خدمات النظم الإيكولوجية السابقة هي غير ملموسة، الا ان القيمة الاقتصادية للأنشطة السياحية فيالمحمية هي ملموسة و متنامية.

معظم الفوائد الاقتصادية المذكورة أعلاه تعود إلى وجود المحمية، إما بشكل كلي او جزئي. على سبيل المثال، تلعب المحمية دورا رئيسيا في تأمين المياه إلى ما لا يقلّ عن 116000 فرد من السكان المحليينوفي الحفاظ على نوعية المياه في المنطقة، وعلى هذا النحو يمكن للمرء أن يؤكد بأن هذه الفوائد لن تكون على نفس المستوى في غياب المحمية.

اما النفقات المرتبطة بالسياحة تعود الى وجود

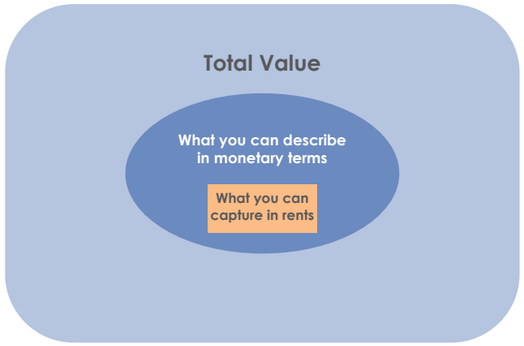
جدول يلخص القيمة الاقتصادية لخدمات المحمية:

خدمات النظم الايكولوجية	القيمة الاقتصادية($\سنة)
الكاربون	
الاحتباس	$860,000
جمع البذور	$50,000
توفير الكتل الحيوية (الوقود الصناعي)	$200,000- $1,000,000
احتياطي المياه	
شبكة المياه (الباروك و الصفا)	$8,437,500 - $11,250,000
شبكة المياه (المنطقة الشرقية)	$785,250 - $1,047,000
صناعة تعبئة المياه	$2,640,000 - $3,360,000
الفوائد البيئية الايكولوجية لمستنقع عميق	$600,000
الطاقة الكهرومائية	$1,300,000
توفير المواد الغذائية	
المراعي للإنتاج الحيواني	$600,000
المنتجات الريفية	$130,000
انتاج العسل المتزايد	$450,000
السياحة	
رسوم الدخول السياحي	$186,000
الاقامة في بيوت الضيافة	$79,000
المطاعم التقليدية	$247,500
طاولة عميق (مطعم بيئي)	$200,000
الخدمات الثقافية	غير مقدرة نقديًا
المجموع العـــــام	$16,765,250 - $21,359,500

المحمية، لأنه في غياب المحمية قد تنشأ سياحة غير منظمة التي من شأنها ان تستنزف في نهاية المطاف الموارد الطبيعية وتؤدي الى تدهورها. وكذلك، ان احتباس الكربون وإمكانية إنتاج الكتل الحيوية هي فقط بفضل الإدارة المستدامة التي يكفلها وجود المحمية وفريق عملها.

ومن المهم التأكيد على أن الدراسة لم تتطرق إلى التفصيل في قضايا الإسناد ولم تحاول الإجابة عن سؤال صعب : كم من هذه القيمة سيظل هناك إذا لم تكن المحمية موجودة؟ هذه هي احدى المجالات التي تتطلب المزيد من البحث و المناقشة، لأنعملية تحديد الإسناد ليست سهلة أو مباشرة، وغالبا ما تعتمد على الاحكام الشخصية. ان عنصر الإسناد لم يتم تحليله بشكل كامل، ومن الجدير ذكره أن العديد من السلع والخدمات التي تقدمها المحمية لم تقدر في هذه الدراسة.

من غير الممكن وصف القيمة الاجمالية لمحمية الشوف المحيط الحيوي من الناحية النقدية. إنّ هذه الدراسة تصف فقط الجزأين المتعلقين بالمربع الأوسط (يمثل ما يمكننا احتسابه من الايجارات) والحلقة الوسطى الزرقاء الداكنة (تمثل ما يمكننا وصفه من الناحية النقدية) وهي لم تتطرق إلى الجزء المتعلّق بالمربع الأزرق.



لذلك، عند تفسير النتائج المعروضة في هذه الدراسة، لا بد من أن نتذكر أنها تعكس فقط جزء واحد من القيمة الإجمالية للخدمات التي تقدمها المحمية. وعلى الرغم من هذه القيود، فان القيمة الاقتصادية للمحمية (متوسط 19 مليون دولار اميركي) تتجاوز بكثير الميزانية السنوية للمحمية (حوالي 1 مليون دولار تشمل الاستثمارات وخدمات الصيانة) بمقدار 20 ضعف. ببساطة، عند إستثمار دولار واحد في محمية الشوف المحيط الحيوي، يعود نحو 20$ من الفوائد على المنطقة وسكانها.

الطبيعة لا تقدر بثمن وبالتالي فإن محمية الشوف المحيط الحيوي لا تقدر باي ثمن أيضاً.

III. ABOUT THE SHOUF BIOSPHERE RESERVE

The Shouf Biosphere Reserve (SBR) is Lebanon's largest reserve. Originally established in 1996 as a Nature Reserve based on Law 532/1996, the Reserve acquired several local and global designations including "Biosphere Reserve" in 2005(UNESCO). The SBR today covers 499 Km2 broken down as follows:

Table 1.
Shouf Biosphere Reserve area and zones

Zone	Area (in Km^2)	Percentage
Core Zone	161	18.64%
Buffer Zone	54	17.23%
Development Zone	233	64.13%
Total	448	100.0%

The SBR has five reserve entrances (Barouk, Maasser, Ain Zhalta-Bmohray, Niha, and Mrusti) which combined receive 60,000-70,000 visitors per year, injecting money in the Shouf region including LL360 million – LL420 million in the Reserve itself in the form of entrance fees and food services. At least 22 towns and villages participate in the management of the SBR, in one way or another, and reap its benefits through tourism, agriculture, and other environmental services. The total population in the transition zone is about 116,000 (see breakdown in Table 2) and winter migration can reduce the population by about 40%.

Ecologically, the SBR represents a unique ensemble of species. It harbors a rich flora with about 520 species of plants. Many of

Table 2.
SBR Towns and Villages and Population

Village	Economic Activities	Population
Ain Dara	Employees, Agriculture	7500
Ain Zhalta	Employees, Agriculture, Pastoralism	6000
Bmohray	Employees, Agriculture	2500
Barouk / Fraidiss	Employees, Agriculture, Pastoralism	6000
Batloun	Employees, Agriculture, Pastoralism	3500
Maasser	Employees, Agriculture	5000
Khreibeh	Employees, Agriculture	2500
Mrusti	Employees, Agriculture	2300
Jbaa	Employees, Agriculture	2000
Niha	Employees, Agriculture, Pastoralism	7000
Baadaran	Employees, Agriculture	3000
Qeb Elias	Employees, Agriculture	50,000
Ammiq	Employees, Agriculture	1000
Aana	Employees, Agriculture	1500
Kefraya	Employees, Agriculture	1200
KherbitKanafar	Employees, Agriculture	3000
AinZebdy	Employees, Agriculture	500
Bab Marea	Employees, Agriculture	3000
Saghbine	Employees, Agriculture	6000
Aitanit	Employees, Agriculture	2500
Mashghara	Employees, Agriculture	16,000
Total		116,000

Photo:
Views over the iconic Lebanese cedar Cedrus libani in the SBR

these plants are medicinal, some are edible, and others are aromatic. The Reserve is home to 25 internationally and nationally threatened plants; 48 plants endemic to Lebanon or the Syria/Lebanon/Turkey area; 14 rare plants; and 214 plants that are restricted to the Eastern Mediterranean or Middle East area.

The SBR is most famous for its large and self-propagating stands of Lebanese cedar, Cedrus libani. The cedar is a highly symbolic conifer, and one of most cited plants in history, religion, and mythology. The Reserve represents the natural southern limit of this tree, and harbors about 620 ha of cedar forest which represents about 30% of Lebanon's total cedar forests. Since 1996, when the area was designated a Nature Reserve by parliament, the cedar forest of the SBR has been protected from overgrazing and human interference and started to show clear signs of natural regeneration. In some locations, the regeneration is extensive.

The SBR is today a vibrant community, creating jobs and income for many local residents. At least 110 people benefit directly from the SBR through jobs and services (see summary in Table 3).

Table 3
Jobs related to the SBR

Item	Number
Permanent staff	25
Seasonal workers	20
Guesthouse owners	7
Women (Rural Development & Handicrafts)	50
Local Guides	10

ECOSYSTEM SERVICES IN THE SHOUF BIOSPHERE RESERVE

IV. ECOSYSTEM SERVICES IN THE SHOUF BIOSPHERE RESERVE

Ecosystem Services are "the benefits people derive from ecosystems" (Millennium Ecosystem Assessment, 2001). Those include provisioning services such as food, water, wood, plants and other raw materials; regulating services such as flood control; supporting services such as prevention of soil erosion, pollination of crops and water purification; as well as a vast array of cultural services such as tourism, recreational and cultural benefits. These services are tabulated below.

Category	Illustrative Examples
provisioning services	food and fresh water
regulating services	climate regulation and flood defense
cultural services	recreation, tourism, education and aesthetic appreciation
supporting services	soil formation and nutrient cycling

In spite of the ecological, cultural and economic importance of these services, ecosystems and biodiversity are still being degraded at an unprecedented scale. The value of ecosystems to human welfare are still not fully understood, are underestimated, and are usually not appropriately recognized in planning and decision-making. The benefits of ecosystem services are not captured easily in "conventional market economics", with the economic and financial costs of externalities of development including pollution and deforestation, among others, usually left unaccounted for.

Quantifying and putting a dollar value (Valuing / Monetization) of such ecosystem services can help decision makers in developing approaches to better understand and maintain such services to achieve better, and longer-lasting, economic development objectives.

Based on in-depth discussions with SBR staff, it was agreed that this study would focus on the following five broad ecosystem services as these were estimated to be the most significant ones:

(1) Carbon (sequestration and biomass)
(2) Water provision
(3) Food provision
(4) Tourism and recreational opportunities
(5) Cultural values

It is important to note that the value of economic activities and impacts linked to ecosystem services already reflect in part some of the value of the ecosystem services involved. Figure 1 overleaf summarizes the main ecosystem services considered and how we have estimated their value.

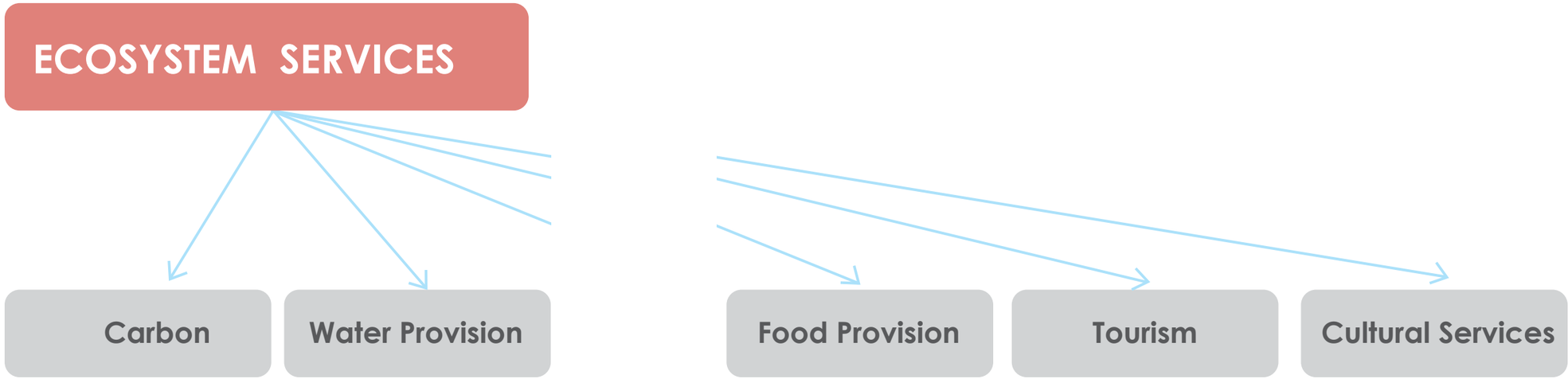
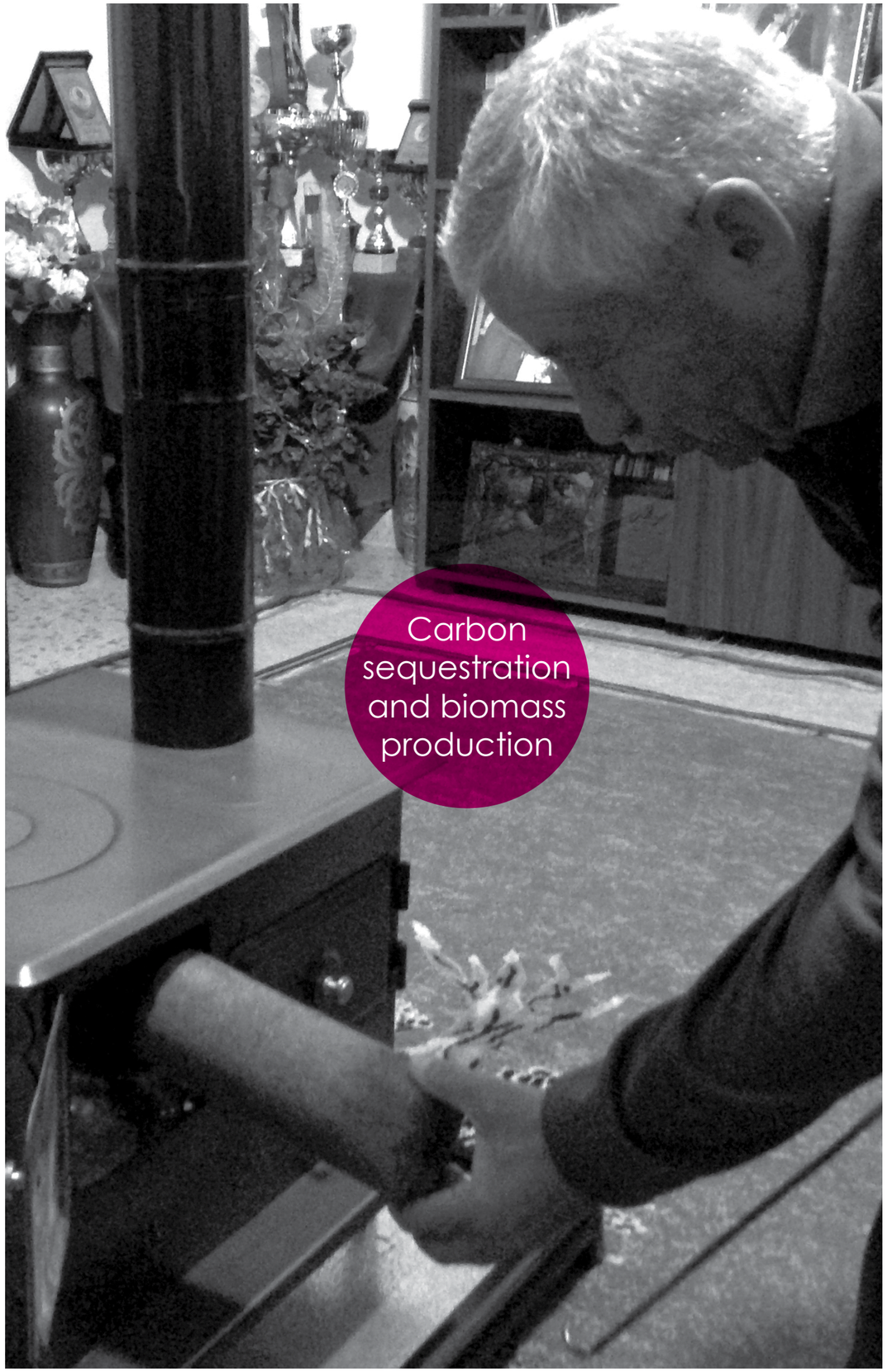


Figure 1
An overview of theEconomic Value of the Shouf Biosphere Reserve



Carbon sequestration and biomass production

4.1 Carbon sequestration and biomass production

The SBR acts as a carbon sink, sequestering atmospheric CO2. It also generates a substantial quantity of wood and other organic products from forest thinning operations, coppicing, and agriculture. If salvaged, those can be used as an energy source in the form of briquettes. At least one production facility inside the SBR is currently producing briquettes for domestic use, at the rate of about 600,000 briquettes per year. The facility intends to increase production subject to the availability of raw materials. Although carbon sequestration and briquette burning have opposite impact on the carbon cycle (sequestration locks atmospheric carbon in the biomass whereas burning will release carbon back into the atmosphere), the net impact of both processes was not assessed in this study. Carbon sequestration is valued using the social cost of Carbon, for which several estimates exist, whereas biomass production (i.e. briquettes) is monetized through its economic activity value.

Carbon sequestration

SBR carbon sequestration reduces atmospheric CO2 concentrations at local and global levels.

In 2011, EcoAid, a private carbon management company, assessed the carbon sequestration potential of the SBR. Using conservative assumptions adopted by UK Forestry in carbon calculations, EcoAid estimated that the cumulative sequestration potential of three dominant forest species (cedars, oaks and pines) in the core area over a 10-year period at 232,557 total MT CO2e.[1] On average, this could be considered 23,255 MT CO2e/year, and can be monetized. Using $37 / MT of CO2e, [2] the economic value of carbon sequestration in the forested area would equal to:

23,255 MT CO2e/year x $37 / MT of CO2e = $0.86 million / year

Equally important, the SBR has become a preferred destination for ecological restoration. Over the last decade, the Reserve has rehabilitated 100ha through reforestation and seeding, at the average cost of $5000 per hectare. This is equivalent to a $500,000 investment that will increase

What is Carbon sequestration?

Carbon sequestration means capturing carbon dioxide (CO2) from the atmosphere. In terrestrial / biologic sequestration, plants capture CO2 from the atmosphere and store it as carbon in their stems and roots as well as in the soil. In photosynthesis, plants take in CO2 and give off the Oxygen (O2) to the atmosphere as a waste gas. The plants retain and use the carbon to live and grow. Terrestrial sequestration is a set of land management practices that maximizes the amount of carbon that remains stored in the soil and plant material for the long term. No-till farming, wetland management, rangeland management, and reforestation are examples of terrestrial sequestration practices.

[1]Cedrus sp. (14%), Quercus spp. (67%), and Pinus spp. (19%)
[2]http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf

ecosystem services and generate additional economic benefits in the future (including carbon sequestration and soil retention).

Biomass Production

SBR's biomass production potential includes woodchips from deciduous forests (mostly oaks such as Quercus calliprinos and Quercus infectoria), pruning of pine trees (mostly on abandoned terraces or steep hillsides), woodchips from agricultural waste (mostly pruning of fruit trees including almonds and olives), and olive cake from the olive press industry. Only the undergrowth of the deciduous forests can be used because it is illegal to cut conifers. It is understood that clippings refers to pruning the lower branches up to 2.5-3 meters off the ground.

A recent study conducted by **Sylvestris**, a Spanish engineering firm specialized in forest management and biomass, calculated the total biomass potential of a 21.34 km2area inside the development zone. The area was divided into 7 homogenous units, and total production was estimated in tons of biomass per year. It was determined that the total biomass potential is approximately 184.25 T/km2 per year (with 45% moisture content), which is equivalent to 3,932 tons for the study area. The biomass potential assumes that the maximum extractions rates are respected and will not affect ecosystem health or natural regeneration. Assuming that the study zone is representative of the wider SBR, then the following extraction rates can potentially be achieved:

Table 4.
Potential for sustainable biomass extraction in Tons per Year

Zone	Area (in Km^2)	Biomass T per year at 45% moisture content
Core Zone	161	17,135
Buffer Zone	54	15,845
Development Zone	233	58,960
Total	448	91,940

In practice however, wood extraction is banned within the core zone because the primary objective of this zone is to serve ecological functions and must therefore respect strict conservation rules.

The study then estimated the total biomass required to produce 1 million briquettes per year at a local briquette production facility. Using different combinations of raw materials including forest woodchips, agricultural woodchips, and olive cake, the study estimates that 1,200 tons of biomass is needed to produce 1 million briquettes (1 briquette = 1.2 kg). The average moisture content of briquettes is 17%, which is lower than the moisture of wood chips (45%) and olive residues (30%). At the going unit price of LL300 per briquette (about $166 per ton), one million briquette would fetch LL 300 million ($200,000). The facility intends to increase production, over a 10-year period, from about 600,000 (current) to 5 million. The resulting revenue stream is summarized below.

Table 5.
Briquette Production and Potential Revenue Stream in the SBR

Year	T biomass / Year	Briquettes / Year	Gross Revenues $/Year
2014	720	600,000	$120,000.00
2015	1200	1,000,000	$200,000.00
2016	1488	1,240,000	$248,000.00
2017	1845	1,537,600	$307,520.00
2018	2288	1,906,624	$381,324.80
2019	2837	2,364,214	$472,842.75
2020	3518	2,931,625	$586,325.01
2021	4362	3,635,215	$727,043.02
2022	5409	4,507,667	$901,533.34
2023	6707	5,589,507	$1,117,901.34

Seed production and forest nurseries

Over the years, Lebanon has developed and honed its skills in plant propagation and seed germination. The country abounds with reforestation programs, many of which have received seed money as well as technical assistance from international organizations and institutions, including CSR programs with private establishments.

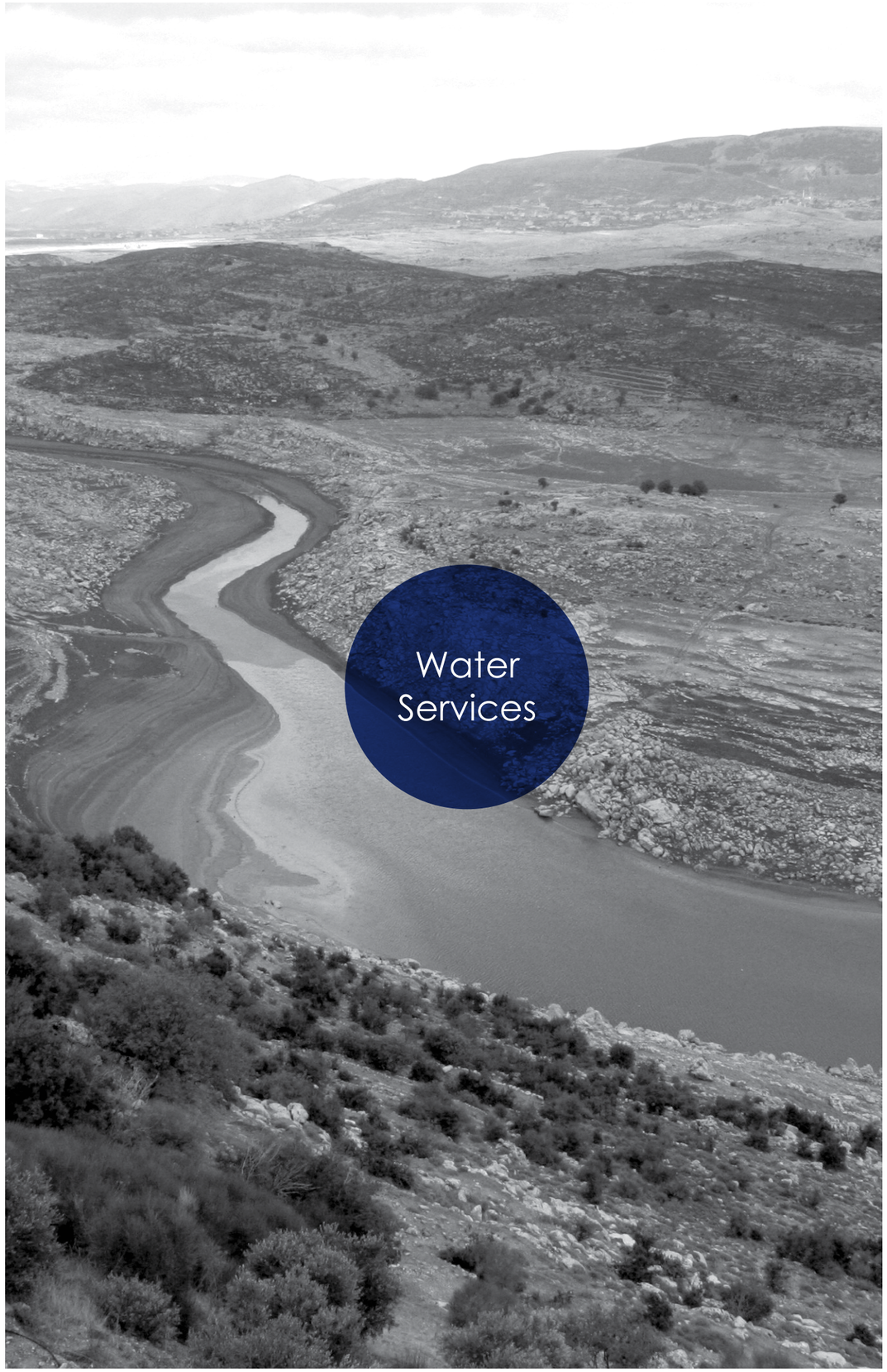
The SBR offers a unique and extensive seed bank for plant nurseries. These nurseries collect seeds from many areas of the country including the SBR. At least two of Lebanon's largest and finest nurseries are able to satisfy some of their needs from the SBR, as summarized below:

Photo:
sample of a briquette

Table 5.
Briquette Production and Potential Revenue Stream in the SBR

Nursery	Annual Production	% Collection from SBR	Annual production from SBR seeds
Nursery of Mr. Khaled Sleem (Native Plants)	80,000	20%	16,000
Association for Forest Development and Conservation	100,000	35%	35,000

At the selling unit price of $1 per 1-year old seedling, the SBR is directly generating $51,000 in revenues from the production and sale of forest seedlings. The rate of production could easily increase ten folds but it is limited by institutional capacity (not seeds).



4.2 Water Services

The SBR is a water tower. It constitutes a region-wide water capture and recharge zone which benefits at least 21 villages and towns with a total population of 116,000, dozens of commercial facilities including restaurants and cafés, and three commercial water bottling industries. The SBR also nourishes several perennial rivers (Litani, Damour and Awali) and about 231 springs including more than a dozen perennial springs (see Exhibit 1). Some of those springs are either tapped by water utilities or by local residents who traditionally fill water jugs from these springs because there is a general perception that spring water is better than grid water. Untapped surface water flows freely and supports downstream ecosystems (better known as "environmental water" or water which serves ecological purposes).

Exhibit 1
Rivers and springs in and around the Shouf Biosphere Reserve

The SBR lies over an interesting geological formation that give rise to many springs. Springs have an ecological value as they sustain riparian (water-dependent) ecosystems downstream. As part of a recent campaign to identify, document, and test water springs on the 470 Km Lebanon Mountain Trail (LMT)[3], seven springs in the SBR were tested for bacteriological pollutants during two sampling campaigns (fall 2013 and spring 2014). The results show that three springs have no bacteriological contamination, three have low contamination and one spring has moderate contamination. None of the tested springs is highly contaminated and only one spring was moderately contaminated – see summary of test results in Table 6. By comparison, a higher percentage of springs in other regions on the LMT were contaminated.

Water connections (grid water)

The communities around the SBR are administratively linked to the Beirut and Mount Lebanon Water Establishment (BMLWE), one of four establishments in Lebanon. The BMLWE comprises many smaller water offices including two main water offices in the Shouf: Barouk and Safa. The eastern flank of the SBR is hydraulically connected to the Bekaa Valley, which is administered by the Bekaa Water Establishment. Table 7 shows the number of water customers in Barouk, Safa, and the Eastern district (West Bekaa).

[3] *www.lebanontrail.org*

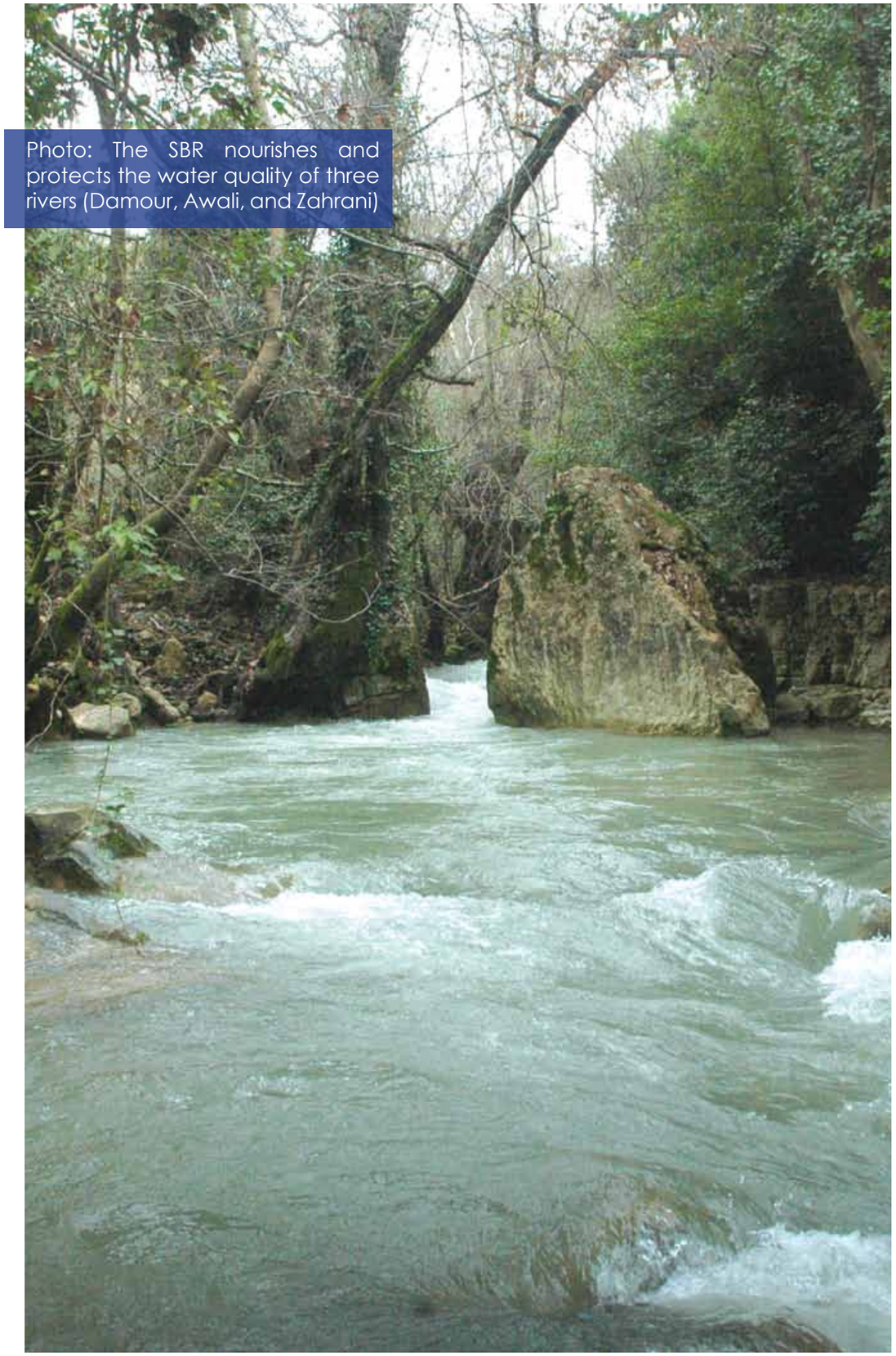


Photo: The SBR nourishes and protects the water quality of three rivers (Damour, Awali, and Zahrani)

Table 6
Bacteriological water quality of seven springs in the SBR and on the Lebanon Mountain Trail

Region	Location	Bacteriological Contamination			
		No	Low	Moderate	High
AinMaaser El Shouf	Maaser El Shouf		•		
Ain al Baton	Niha			•	
Ain al Halkoum	Niha	•			
Ain al Shaashoua	Jbaa		•		
Ain al Zghireh	Maasser El Shouf		•		
Ain al Aazamain	Aitanit	•			
Ain al Dayaa	Aitanit	•			

Source: LMT Association (samples tested at the Industrial Research Institute), 2013-2014

Using a fixed water tariff of LL225,000 ($150) per customer per year (1 m3 gage), and assuming 100% collection rates, total revenues from 75,000 paying customers in Barouk and Safa would reach LL22.5 billion ($11.25 million); and LL1.5 billion in the eastern district. We have assumed two attribution scenarios: 75% and 100%. The resulting values would be $9.2 million and $12.3 million, respectively. Naturally, the water utilities incur O&M costs to maintain the service and, in practice, collection rates never reach 100%. Still, the presence of the SBR contributes significantly to recharging the aquifers and maintaining water quality thereby reducing water treatment costs downstream.

Table 7
Water supply data and number of water subscribers:

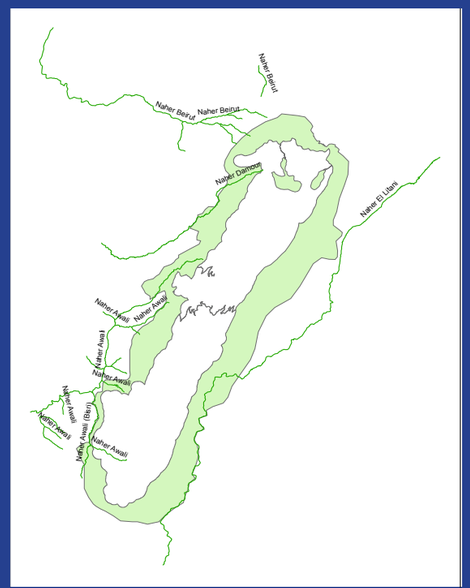
Water Utility	Water Subscribers			Water Supply (m3/ day)
	2011	2012	2013	
Barouk	70,000	72,000	75,000	60,000
Safa				
Eastern district*	6,920			n/a

Source:
SBR based on unofficial data from the region
Eastern district: Aitanit, Bab Mareh, Saghbine, Ain Zebde, Khirbet Kanafar, Aana, Ammiq, Kefraya, and Qab Elias

Support to wetlands

The SBR is home to Lebanon's largest wetland, Ammiq Wetland. Proclaimed a Ramsar site of international importance, this 100ha site supports hundreds of species. It

Exhibit 1
Rivers and springs in and around the Shouf Biosphere Reserve



represents the last extensive wetland in Lebanon (much reduced compared to its original size half a century ago before the advance of intensive agricultural systems that drained much of the West Bekaa).

The box shows some valuation study results of international wetlands, along with a very preliminary estimate of the potential value of the economic and environmental services provided by the SBR's Ammiq Wetlands: conceivably somewhere in the order of $600,000/year. For comparison purposes, if the entire core area of the SBR (100 km2) were a wetland instead, its value may be in the order of $60 million/year or more.

Man-Made Water Bodies

The SBR is not only an important recharge zone; it is also a preferred destination for the construction of hill lakes and storage ponds. These man-made water reservoirs provide water to various ecological activities including:

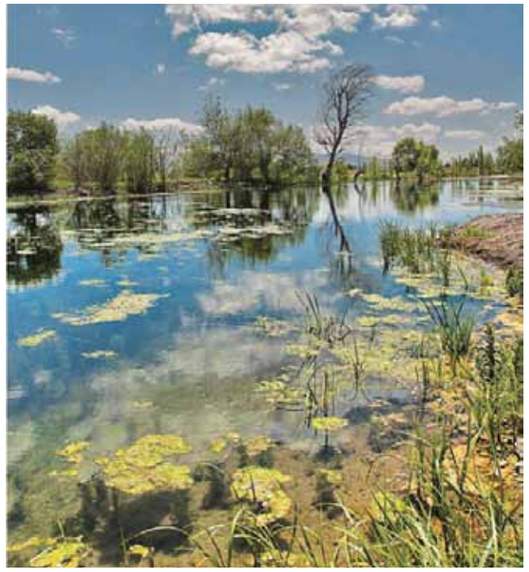
(1) Forest fire fighting (by Lebanese Army Huey helicopters and Civil Defense trucks)
(2) Reforestation (by drip irrigation of forest seedlings and new plantations)
(3) Agriculture (by drip irrigation of orchards)

The SBR has about 10 hill lakes and storage ponds, listed in Table 8.

Equally important, man-made water bodies are attraction points for water birds. They also supply water to fauna (provided adequate measures are implemented to prevent drowning), and to fire-fighting events including the Civil Defense and Lebanese Army helicopters. The bird-watching potential in the SBR was valued in the year 2000 at $43,500. Assuming the current number of visitors is maintained, the current recreational value of migratory bird watching in the SBR is approximately $65,138 in 2013 prices. This value however is essentially already covered (implicit) under rural tourism and visitor spending.

Water treatment costs

The presence of the SBR prevents and/or controls land use activities in the core area and development zone, some of which would result in soil and water pollution. Although utilities will treat water (filtration and chlorination) regardless of the water source and water quality, it can be assumed that water treatment costs will increase if the SBR did not exist, and if land use activities were not controlled inside the catchment area. Currently, there are three treatment stations in the SBR region and the annual O&M cost per station is about $20,000. The annual O&M cost of abstraction wells is about $5,000.



The Economic Value of Some of the World's Wetlands and the Potential Value of SBR's Ammiq Wetland

Some results of economic valuation studies of wetlands (in 2013 prices):
- Muthurajawela Wetland (3,068 ha), Sri Lanka: $6,204 / ha
- Charles River Basin Wetlands (3,455 ha), USA: $33,968 / ha
- Whangamarino Wetland (10,320 ha), New Zealand: $1,238 / ha
- Dutch Wadden Sea (270,000 ha), Netherlands: $9,884/ ha

Services valued include carbon sequestration, amenity value, water pollution treatment and control, freshwater supplies, storage and recycling of nutrients, fisheries and agricultural production, flood prevention and control, habitats and nurseries, leisure and recreation, spiritual / historical, educational values, etc.
Applying a simplified Benefits Transfer (adaptation) approach to the SBR's 100 ha Ammiq Wetland suggests a value potentially somewhere in the order of $600,000 / yr, but could range from as low as $30,000 / yr and up to $2 million / yr depending on the specific services included.
Source: adapted from Schuyt and Brander (2004)

Hydropower Production

Located in Richmaya, the Safa hydropower plant was built in 1931. Unlike other hydropower plants in Lebanon, the Richmaya plant is owned and operated by Electricité du Liban[4] and has a nominal capacity of 13 MW. The plant is in service but in need of rehabilitation. It is currently operating at 60% capacity, generating 16,300 MWhr yearly. Assuming 95% is sold at a unit price of $0.08/Kwh, the total yearly sales amount to $1.3 million. It is assumed that by enhancing water recharge, the SBR is securing the flow necessary to run the hydropower plant and generate electricity. Without the SBR, urbanization and other land use activities would gradually alter the hydraulic regime of Safa watershed resulting in reduced electricity production.

Table 8. Natural and Man-Made Hill Lakes in SBR

Hill Lake Name	Longitude	Latitude	Elevation in meters
Ain Zhalta Hill Lake	33.7419	35.7433	1821m
Ammiq Wetland	33.7245	35.7885	868m
Ammiq Lake	33.7356	35.784	871m
Ain El Lejjeh Small Lake	33.6944	35.7355	1534m
Barouk Hill Lake	33.6936	35.7115	1707m
Maasser Lake	33.6582	35.6711	1192m
Khreibeh (1)	33.6481	35.6545	1252m
Khreibeh (2)	33.6429	35.6479	1139m
Khreibeh (3)	33.6429	35.6425	1091m
Khreibeh Lake	33.6339	35.6461	1251m
Mrosti (1)	33.6416	35.6519	1278m
Mrosti (2)	33.6409	35.6546	1328m
Mrosti (3)	33.6394	35.6539	1328m
Mrosti (4)	33.6378	35.6624	1246m
Mrosti (5)	33.6373	35.6599	1231m
Mrosti (6)	33.6360	35.6593	1254m
Mrosti (7)	33.6347	35.6609	1290m
Mrosti (8)	33.6308	35.6576	1294m
Mrosti Lake (1)	33.6309	35.6587	1310m
Mrosti Lake (2)	33.6219	35.6683	1682m
Jbaa	33.6147	35.6467	1212m
Jbaa Lake 1	33.6089	35.6427	1189m
Jbaa Lake 2	33.6041	35.6414	1219m
Jbaa (3)	33.6025	35.6399	1199m
Jbaa (4)	33.6006	35.6381	1185m
Niha (1)	33.5951	35.6425	1356m
Niha (2)	33.5811	35.6201	1284m
Niha (3)	33.5656	35.6248	1397m
Niha Lake	33.5782	35.6325	1219m
Qaraoun Lake	33.5749	35.6989	868m

Man-made lake in Barouk (El Shouf) for fire-fighting

Man-made lake in Ain Zhalta for bird watching

Water Bottling Industries

There are four well-known and licensed water bottling industries in the SBR (see Table 9). With the help of the SBR team, ECODIT was able to obtain partial flow data from two plants based on formal requests. The data show that the largest two plants (Nestlé and Nada) pump about 8,000 to 10,000 m3/year. The water is bottled in different container sizes including large gallons (19 liters), 2-liter, 1.5-liter, and 0.5-liter bottles. Assuming an average unit price of LL500/liter (regardless of container size), then the total value of their combined production ranges from $2.64 million to $3.36 million (gross revenue).

There are many more, and small-scale water bottling plants in the region but those are often unlicensed and water quality monitoring is absent. Nonetheless, the water bottling sector in Lebanon is a thriving multi-million dollar industry which has been able to grow steadily over the years due to a persistent lack of consumer confidence in the quality of grid water.

The significance of bottled water consumption in Lebanon cannot be sufficiently emphasized. Studies and surveys by the Central Administration of Statistics confirm that about 40% of households buy mineral water in gallons and 12% - 15% of them buy mineral water in bottles.

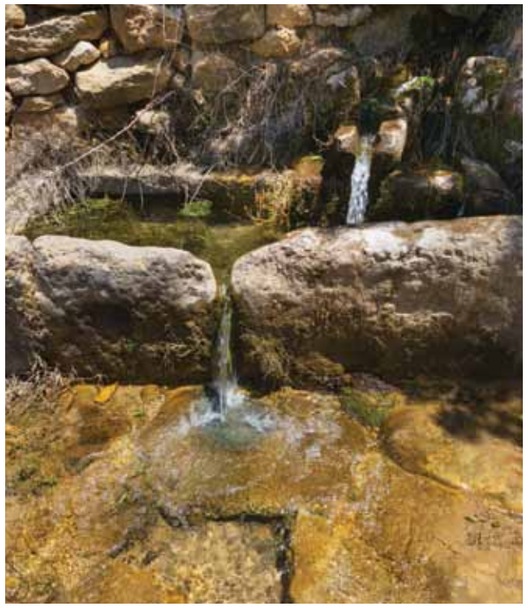


Table 9.
Commercial Water Bottling Plants in SBR

Name	Location	Number of Wells	Abstraction	
			m3/day	m3/year
Nestlé	Ain Zhalta	2	15-20	5,400 – 7,200
Nada	Haret Jandal	4	7-8	2,520 – 2,880
Dana	Niha	Not Available	Not Available	
Al Naha	Ain Dara	Not Available	Not Available	
Total	-	-	-	7,920 – 10,080

Source: MOPH List of Licensed Water Bottling Companies (2014) and abstraction data from the water plants
Note: Abstraction is based on 360 days of operation per year

[4] *http://www.edl.gov.lb/about%20EDLa.htm#4*

4.3 Food Services

Rangelands

The SBR provides 1000s of hectares of rangeland. Rangelands worldwide play an important role in the provision of feed to animals and also help conserve water by improving recharge. There are two types of rangelands: tame and natural pastures. The SBR offers natural pastures that have not been planted by people and offer a variety of native species including grasses, forbs, and shrubs.

As part of a 2011 field study commissioned by the SBR to assess the carrying capacity of the Reserve, it was determined that the Reserve offers approximately 12,400 ha of rangelands. It was further evaluated that these rangelands can accommodate around 40,000 heads of small ruminants, during six months of the year. The survey however showed that the total number of heads has drastically declined since the establishment of the Reserve in 1996, and today totals about 12,500 heads.

Based on discussions with shepherds and professionals in animal husbandry, one goat generates about $800 in revenues per year including milk, meat, and skin. Assuming 60% of this value is attributed to ecosystem services provided by the reserve (water and rangelands), then the total value of SBR dependent animal production is about $600,000 (12,500 heads x $800/year x 60%)[5].

Rural products

The popularity of SBR rural products has increased steadily over the years. The most solicited products are Cedar Honey, Oregano with Pine nuts, and Rose and Almond Jam. Total annual sales during the period from 2010 to 2013 has ranged from LL166 million ($111,000) in 2011 to LL248 million ($165,000) in 2012 (see Table 10).

Table 10. Annual Revenues in LL from SBR Rural Products between 2010 and 2013

Year	Barouk	Maasser	AinZhalta	Niha	Park House	Other	Total
2010	155,653,000	39,325,000	0	0	0	0	194,978,000
2011	111,648,000	32,891,000	3,700,000	4,591,000	13,512,000	0	166,342,000
2012	73,704,000	23,706,000	11,235,000	6,210,000	7,878,000	125,350,000	248,083,000
2013	46,995,000	30,511,000	4,366,000	7,953,000	7,506,000	74,292,000	171,623,000
						Avg. in LL	195,256,500
						Avg. in US$	$130,171

Source: Data compiled and provided by SBR (2010-2013)
Note: "Other" includes TSC (supermarket), Tawlet Ammiq (eco-restaurant) and other outlets

[5] *Pers. Comm. Dr. Mounir Abi Said, Mammologist*

Photo: the SBR provides important rangelands for sustainable grazing

On average, total annual revenues from SBR products during the period 2010 to 2013 was $130,000. The socio-economic impact of the program is greater if we include other factors such as indirect job creation, increased flow of tourists, and food festivals.

Additionally, there are more than 3000 (registered) beehives in the villages surrounding the reserve. [6]Beehives inside the SBR reportedly produce 5 kg more honey than similar beehives in other regions; this incremental production is primarily attributed to the quality and abundance of pastures (pesticide-free, limited grazing) and forests (no fires). The incremental value of honey production in the SBR is equivalent to $450,000 per year (3000 beehives x 5kg/hive x $30/kg).

[6] لائحة بالنحالين الذين يملكون قفران نحل مرقمة مع التغيرات في الاعداد (وزارة الزراعة)
List of beekeepers who own numbered beehives (Ministry of Agriculture)

4.4 Tourism

The SBR has become a magnet for alternative tourism in Lebanon (rural, ecological, research, etc.). The related activities generally fall under a wider euphemism called "responsible tourism". In recent years, the SBR has attracted contributions and funding to build and/or restore several tourism facilities and amenities including the SBR Park House in Maasser el Shouf (an investment worth $600,000); Tawlet Ammiq (an ecological restaurant in Ammiq, at $800,000); five reserve entrances (at $100,000 each); half a dozen guesthouses (at $15,000 each); and 250km of walking trails (at $1000 per km). These investments represent a total cost upwards of $2.2 million and have contributed to scaling up the tourism capacity and recreational experience in the SBR. Most of these investments would not have been possible, and funding would not have been available, in the absence of the SBR.

Visitor numbers and spending

The number of visitors has been increasing steadily since the Reserve was established in 1996. In recent years, the number of annual visitors seems to have plateaued at around 60,000 to 70,000 spread across five entrances (see statistics in Table 11). Entrance fees are LL5000 for tour operators and groups and LL7000 for individuals.

Table 11.
Number of Visitors to SBR from 2010 to 2013

Year	Barouk	Maasser	Ain Zhalta Bmohray	Niha	Mukhtara	Total
2010	37927	15199	1665	3282	NA	58073
2011	40189	18308	4805	3974	NA	67276
2012	37195	14354	6033	3674	360	61616
2013	40688	13828	3671	3590	718	62495

Source: Compiled and provided by SBR

Table 12.
Revenues from Visitors at SBR Entrances in LL (2010 to 2013)

Year	Barouk	Maasser	Ain Zhalta Bmohray	Niha	Mukhtara	Total
2010	161,153,000	66,920,000	6,046,000	8,724,000	0	242,843,000
2011	171,968,000	69,811,000	12,650,000	10,430,000	0	264,859,000
2012	206,702,000	80,222,000	18,334,000	15,236,000	1,659,000	322,153,000
2013	170,555,000	83,458,000	17,759,000	14,449,000	3,177,000	289,389,000
					Avg. LL	279,811,000
					Avg. US$	$186,540

Source: Compiled and provided by SBR

Visitors spend time and money inside the Reserve (see Table 12) and partake in other SBR-related activities in the region including festivals, cultural tours, agricultural events, and competitions. On average, total revenues from visitors at SBR's five entrance is LL280 million ($186,000).

Lodging services

In terms of lodging, the SBR has become an important destination for multiple-day visits. In addition to conventional lodging, the SBR has supported and promoted the services of at least five guesthouses. According to available visitor data (from 2010 to 2013), the number of visitors (overnights) has fluctuated from 617 to 2994. The most profitable year to date has been 2010. The data however should be interpreted with caution as it relies on voluntary data recording by guesthouse owners.

Table 13.
Revenues from lodging services in the SBR (2010 – 2013)

Year	2010		2011		2012		2013	
Guesthouse	**Visitors**	**LL**	**Visitors**	**LL**	**Visitors**	**LL**	**Visitors**	**LL**
Niha	100	4,500,000	65	10,561,000	25	1,687,000	0	0
Baadaran	267	4,614,000	122	2,900,000	0	0	160	3,322,000
Khraibeh	317	11,736,000	541	17,640,000	609	21,465,000	457	18,300,000
Maaser	2162	98,529,000	NA	NA	NA	NA	NA	NA
Barouk	148	7,200,000	20	750,000	70	3,060,000	0	0
Total	**2994**	**126,579,000**	**2723**	**121,851,000**	**2679**	**116,212,000**	**2592**	**111,622,000**
Avg. LL	**119,066,000**							
Avg. US$	**$79,377**							

Source: Compiled and provided by SBR (2010 – 2013); data for Maasser (Auberge) for 2011, 2012, and 2013 estimated based on informal discussions with the Lebanese NOG arcenciel (operator).

Restaurants

The SBR region is famous for its restaurants, especially along its riverbanks and near major springs. These restaurants existed long before the SBR was established and receive thousands of visitors, mostly families, and during weekends. In recent years however, the SBR has prompted new investments closer to the reserve, and most notably along the main road leading to the SBR entrance in Barouk. A quick survey of these restaurants and hotels attests to the appeal of the SBR and its attribution to the growing tourism industry (see survey results in Table 14).

The average spending per guest is $30-35. Although statistics on the total number of guests is not available, we were able to conclude based on the survey that approximately 15% of the total number of visitors to the SBR per year (60,000-70,000) also visit a conventional restaurant, similar to those listed above. Assuming a meal cost $25-30 per visitor, then the incremental contribution of the SBR to conventional restaurants in the region is about $247,500, derived as follows:

15% of 60,000 visitors =
9,000 visitors x $27.5/meal = $247,500

Tawlet Ammiq (Eco-Restaurant)

Built with grant funding from the Swiss Development Agency (SDC), the SBR team in coordination with the Royal Society for the Conservation of Nature (RSCN) inaugurated Tawlet Ammiq in 2012, an eco-restaurant overlooking West Bekaa. After a somewhat timid start, Tawlet Ammiq quickly became an attraction for nature enthusiasts, families, and hikers. In 2013, total sales reached $200,000 ranging between $3000 and $30,000 per month. The restaurant is a unique destination because it was designed based on stringent green building standards and is run by a network of village and mostly female chefs. The appeal of Tawlet Ammiq is attributed to the vistas offered by the SBR.

Table 14. New restaurants on main road leading to SBR entrance in Barouk

Facility	Year Established	Percent of Guests who Visit Because of the SBR
Tourist Restaurant/Guesthouse	2010 (6 rooms)	35-40%
Calmera Hotel	2012 (20 rooms)	30-35%
Challalat Restaurant	2004	30-35%
Baitna Restaurant	2011	35-40%
Medyaf Restaurant	2006	15-20%

Photo: the SBR offers half a dozen guesthouses that can accommodate up to 150 people

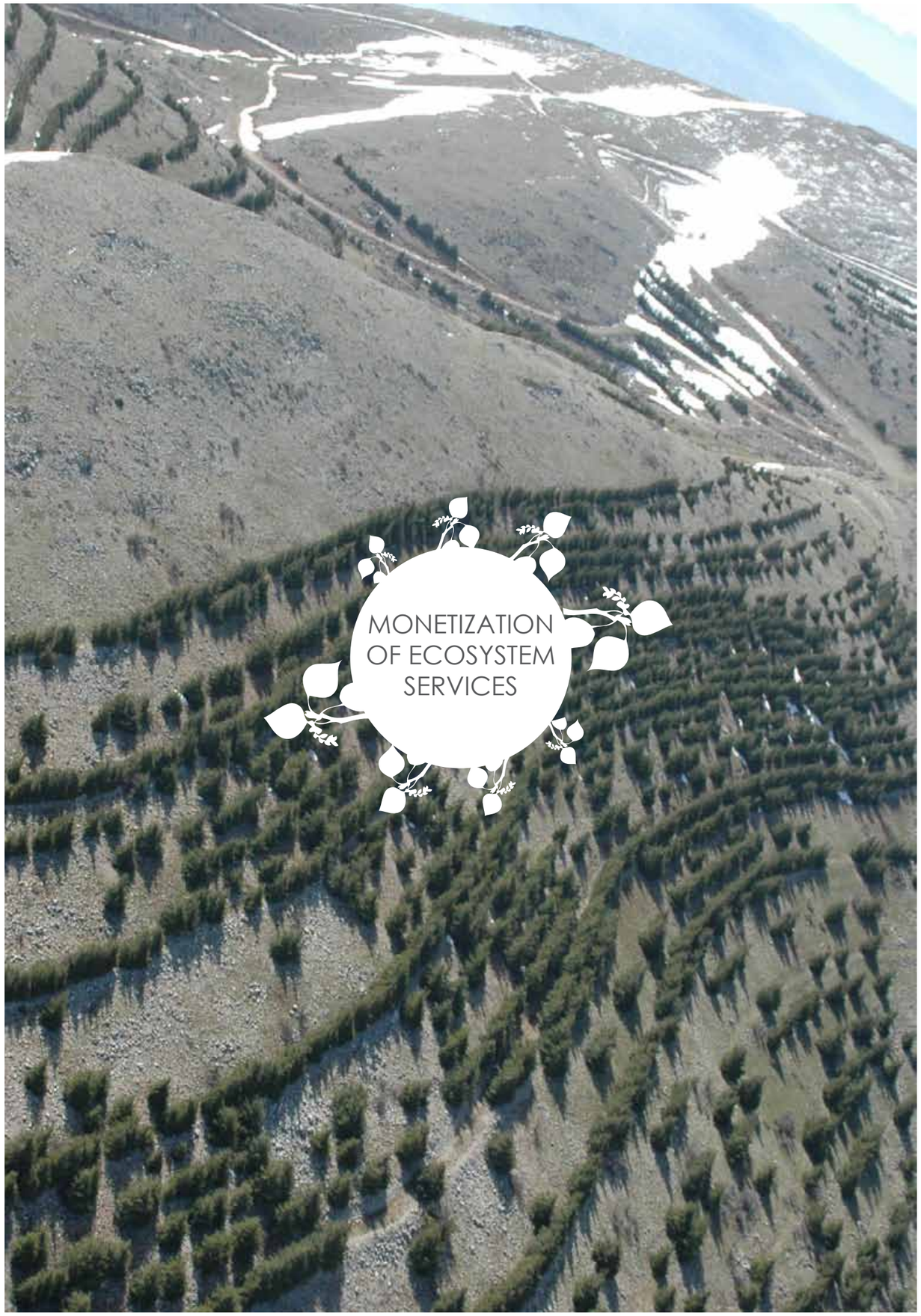
4.5 Cultural Services

The patrimonial value of the iconic cedar tree is priceless. Books and tales have been written about this species and its presence in Lebanon. Most recently, the SBR published a book "Memoirs of a Cedar" to showcase and document the historical and ecological significance of the Lebanese cedar.[7] The book was printed in 2000 copies and sells for 35,000 LL. Notwithstanding the effort that went into the book and distribution costs, and assuming all the copies are sold at full price, then this book project can potentially generate LL 70 million.

The SBR setup the Cedar Loan Program to facilitate micro-loan access by local villagers and residents. As of June 2014, the SBR had received hundreds of applications and approved so far 51 loans worth $1000-$3000 each. The total value of approved loans has reached $122,000, an indication of the program's appeal which is inspired by the management of the SBR and the patrimonial value of the iconic Cedrus libani. Consistent with the vision of the SBR, each loan must have an ecological / environmental benefit. For example, the program was used to fund projects establishing or expanding plant nurseries, rehabilitating lands and stone terraces, and propagating aromatic and medicinal plants. As well as ecotourism services

Another program which is a testimony to the patrimonial value of the emblematic tree is the SBR "Adopt a Cedar Tree Program". Launched in 2003, individuals and organizations can adopt a cedar tree at the unit price of $150 including membership card, certificate, and aftercare (including replacement in case of mortality). In 10 years, 2750 cedar trees have been adopted under the program, generating approximately $42,000. The program is still on-going.

[7] *Memoirs of a Cedar: A history of deforestation – A future of conservation. By Faisal Abu-Izzeddin, Shouf Biosphere Reserve. First Edition 2013.*



V. MONETIZATION OF ECOSYSTEM SERVICES

The estimated economic value of the SBR is summarized in Table 15 according to the five topics described in the study (carbon, water, food, tourism, and culture).

Table 15. Summary of the Economic Value of the SBR and Basis for Calculation

Topic		Basis for Calculation	Present Economic Value ($/Y)
Carbon sequestration and biomass production	Carbon sequestration	Social Cost of CO2-e = $37/MT	$860,000
	Biomass production	Unit of briquette (LL300) and annual production potential (2014 - 2023)	$200,000 - $1,000,000
	Seed production (commercial nurseries)	Contribution of SBR to two prominent plant nurseries	$50,000
Provision of Water	Grid water (Barouk and Safa district)	75,000 subscribers (household connection) at $150 per year (75% and 100% attribution)	$8,437,500 - $11,250,000
	Grid water (eastern Bekaa)	6980 subscribers (household connection) at $150 per year	$785,250 - $1,047,000
	Bottled water	Gross revenue from two large and licenses water bottling plants (Nesté and Nada)	$2,640,000 - $3,360,000
	Value of wetland	Potential value of SBR wetland based on the economic value of some of the world's wetlands	$600,000
	Hydropower	MWhr generation and unit price of electricity = $0.08/ Kwh	$1,300,000
Provision of Food	Rangelands for small ruminant production	Qualitative assessment of rangelands and carrying capacity for grazing	$600,000
	Wild harvesting	Qualitative assessment	Not Estimated
	Rural products	Annual sale of SBR products	$130,000
	Incremental honey production	3000 registered beehives in SBR at 5kg incremental production per beehive at $30/kg	$450,000
Tourism	Entrance fees	Visitor spending at SBR entrances (2010-2013)	$186,000
	Lodging services	Total revenues from lodging in SBR (2010-2013)	$79,000
	Conventional restaurants	Share of gross revenues attributed to SBR visitors	$247,500
	Tawlet Ammiq (eco-restaurant)	Gross revenues in 2013	$200,000
Cultural Services	Book sale	Revenues from book sale	Not Included
	Adopt a Cedar Tree	Revenues from program	Not Included
	Cedar Loan	Total value of loans	Not Included

VI. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The Shouf Biosphere Reserve provides many ecosystems services. Most of these services benefit a wider region (Development Zone) including 22 towns and villages and a total population of about 116,000. The Reserve harbors unique forest ecosystems, including 620 ha of the iconic Cedrus libani representing about 30% of the total Cedar cover in Lebanon. It also stores and protects water resources by controlling land use activities and limiting urbanization in the development zone. In particular, the SBR supplies water to at least 82,000 subscribers as well as four private water bottling plants, representing a multi-million dollar industry.

The estimation of the economic value of the SBR presented in this report is the seed of future research. There are several limitations in this assessment that must be highlighted:

(1) The raw data was incomplete or not obtainable. Nevertheless, this study has assembled valuable baseline information for future research.

(2) Although the value of the SBR is priceless, not all goods and services could be monetized. Several services (climate change regulator, flood defense) could not be valued for lack of numerical data or credible proxy indicators.

(3) Double-counting may be unavoidable. For example, the value of Carbon sequestration (removing carbon from the atmosphere) should in theory deduct the value of carbon emission from briquette production.

(4) Establishing causality between the service and the SBR (attribution). How much of the value of a service can one attribute to the presence of the SBR? This study did not look at attribution in detail but we are confident that the overall benefits of the SBR are still an underestimate of the total value of the SBR.

Based on the above, the findings presented in this study therefore should be regarded as a subset of the overall value of the SBR. Future studies and additional resources should be dedicated to refining the estimation of the economic value of the SBR. In particular:

(1) The attribution effect of the SBR to water services should be explored further

(2) The carbon sequestration potential of the entire SBR should be further analyzed

(3) The economic value of SBR's cultural services should be estimated using several methods including Willingness To Pay surveys

(4) The incremental value of conventional tourism services attributed to the SBR

VII. REFERENCES

(1) Assessment and Evaluation of Grazing Activities at the Shouf Cedar Nature Reserve. Recommendations. By Mounir Abu-Said. March 2012.

(2) Rent in a Warming World, By James K Boyce, Triple Crisis. 21 March 2014.

(3) Restoration Plan. Mediterranean Mosaic Project Shouf Biosphere Reserve (SBR). 2014

(4) Schuyt and Brander (2004), the economic values of the world's wetland, WWF.

(5) Targeted Scenario Analysis, a New Approach to Capturing and Presenting Ecosystem Service Values for Decision Making. UNDP, 2013.

(6) Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 Interagency. Working Group on Social Cost of Carbon, United States Government. May 2013.

(7) Thermal Biomass Project 2013. A Study of Forest Biomass Sustainability prepared by Sylvestris Natural Engineering for the Shouf Biosphere Reserve, Lebanon. December 2013.