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Factors influencing the compensation for reduced acces to Pendjari Biosphere Reserve, Benin: a contingent valuation study

LAURA HASAERS

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Promotor: prof. dr. ir. Steven van Passel

Universiteit Antwerpen

Abstract

Factors influencing the compensation for reduced acces to Pendjari Biosphere Reserve, Benin: a contingent valuation study

The Pendjari Biosphere Reserve in Benin is the most intact ecosystem of West Africa. The reserve is facing some major threats including resource erosion, poaching and encroachment of agricultural land. The human impact on the reserve is increasing with the growing population. The reserve is officially recognized as a Man and Biosphere reserve by UNESCO, implying that sustainable and innovative solutions should be found to support the harmonious integration of humans and nature. The human population living around Pendjari is estimated around 40,000 people. In 2017, the park management was taken over by African Parks. Stricter rules and punishments for exploitation of resources within the reserve were installed for conservation purposes. A large part of the surrounding population depends on services provided by the reserve, the most important one being food provision from agriculture. The assessment of the economic value to the local population of the controlled agricultural zone is conducted through survey based questionnaires using the contingent valuation method. Willingness to accept was measured in money and supported by qualitative discussions about alternative sources of income. The study area contained 19 villages located on the two axes that border the park, located within and just outside the controlled agricultural zone. A total of 150 households were interviewed in order to estimate the economic value of the controlled zone to the ecosystem services provided by Pendjari reserve. The willingness to accept question was asked in an open-ended format. An OLS regression was performed using the point estimates as dependent variable and sociodemographic characteristics as explanatory variables. The factors significantly influencing the stated WTA amount were identified: the distance to the fence line and the income from crop farming. The mean willingness to accept was estimated at 15 911 CFA monthly ($\approx$€24.25), the median 12 500 CFA monthly ($\approx$€19.05). These values together with the most important factors influencing the compensation can be used in cost-benefit assessments to support policy decision-making. Compensation mechanisms should aim to strengthen sustainable development, so a balance between social and ecological systems is reached.

Key words:

Man and Biosphere Reserve, agricultural value, ecosystem services, willingness to accept, contingent valuation, Pendjari, African Parcs

Samenvatting

Ecosysteemdiensten zijn de voordelen die ecosystemen bieden aan mensen. Deze diensten kunnen opgedeeld worden als volgt: ondersteunend, voorzienend, cultureel en regulerend van aard. Enkele voorbeelden van ecosysteemdiensten zijn de voorziening van voedingstoffen, waterregulatie en recreatie. Bij het uitwerken van beleidsmaatregelen omtrent de natuurlijke omgeving is het noodzakelijk om een waarde te kunnen toekennen aan deze diensten. Dit is een moeilijke opgave want in tegenstelling met goederen, is er voor ecosysteemdiensten geen marktwaarde voor handen. Bovendien zijn deze diensten contextueel gebonden en kan er geen uniforme waarde aan worden toegekend. Dit maakt het een interessante opgave om onderzoek over te voeren. Het biosfeerreservaat Pendjari is het grootste intact ecosysteem in West Afrika en is bekend om zijn biodiversiteit in wilde dieren en vegetatie. Het reservaat maakt deel uit van het Man and Biosphere program van UNESCO. Dit programma heeft als doel mensen en natuur te verbinden op basis van onderbouwde managementtechnieken en wetenschappelijke ontwikkelingen. Op deze manier wil UNESCO bijdragen aan de maatschappelijke vooruitgang van de plaatselijke bevolking met het oog op conservatie van de ecosystemen. Pendjari biosfeerreservaat bestaat uit verschillende zones met verschillende regelgeving, mede opgelegd door UNESCO om te voldoen aan de eisen voor een biosfeerreservaat. De drie zones zijn (1) de centrale zones, deze zijn onder volledige bescherming (2) de buffer zones bedoeld om de centrale zones te beschermen en (3) de transitiezones waarin activiteiten mogen plaatsvinden die in lijn zijn met de belangen van de centrale en bufferzones. Een overzicht van de opdeling van het reservaat wordt weergegeven op volgende figuur:
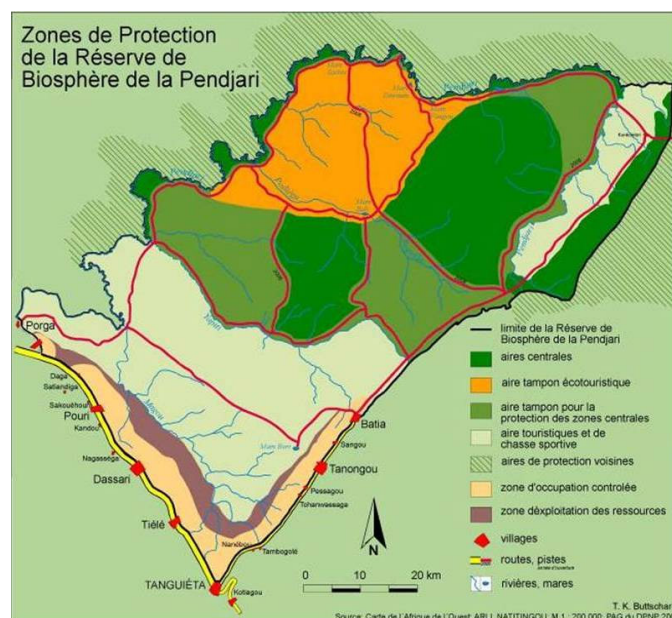
De centrale zones, weergegeven in donkergroen, worden enkel gebruikt voor wetenschappelijk onderzoek. De oranje zones, grijze en lichtgroene zones vallen onder de noemer van bufferzones. Ze worden respectievelijk gebruikt voor ecotoerisme, jacht voor toeristische doeleinden en als bescherming voor de centrale zones. De transitiezones worden weergeven als de gele en paarse gebieden. Deze zones zijn voor gecontroleerde landbouw en exploitatie van natuurlijke bronnen. In deze zones bevinden zich ook dorpen. De populatie in deze dorpen maakt gebruik van de ecosysteemdiensten geleverd door het reservaat. Een voorgaande studie in het gebied toonde de ecosysteemdiensten aan die als belangrijkst werden ervaren door de lokale bevolking. De voornaamste is het voorzien van landbouwgrond voor voedselgewassen, water voor huishoudelijk gebruik en mogelijkheden tot het aantrekken van toerisme. Het doel van deze studie is om de waarde van deze ecosysteemdiensten in kaart te brengen. Deze studie zal vooral focussen op de meest belangrijke ecosysteemdienst voor de populatie, landbouw. Het management van het reservaat is recentelijk veranderd en momenteel wordt het beleid gevoerd door African Parks, een non profit organisatie die nog 14 andere parken in 9 Afrikaanse landen beheert. Het vorige management was in handen van CENAGREF (Centre Nationale de Gestion des Réserves de Faune). Het nieuwe management wil op verschillende vlakken veranderingen doorvoeren ten voordele van conservatie. Deze maatregelen zouden het leven van de omwonende populatie kunnen beïnvloeden. Om de economische waarde van de belangrijke ecosysteemdiensten te achterhalen wordt er gebruikt gemaakt van de *contingent valuation method*. Deze methode valt onder de *stated preference* methodiek, die gebruik maakt van surveys van representatieve samples om uitspraken te kunnen doen over de economische waarde van ecosysteemdiensten. Deze methodiek is echter controversieel, een expert panel van 22 economisten, genaamd het NOAA panel, beschreef daarom in een uitvoerig document richtlijnen waaraan deze surveys moeten voldoen om een waardevolle en interpreteerbare uitkomst te bekomen. Deze richtlijnen hebben te maken met het format van de vragen, de manier van ondervragen maar focussen vooral op het belang van het ontwerpen van een realistisch en duidelijk scenario. Binnen de contingent valuation method zijn er twee manieren om te peilen naar een waarde van een goed of dienst. De ene manier is de betalingsbereidheid (willingness to pay, WTP), dit is het maximum bedrag dat een individu bereid is te betalen om te kunnen beschikken over een goed of een dienst. De andere invalshoek is de bereidheid om te accepteren (willingness to accept, WTA) van een verlies van goed of dienst of een kwaliteitsverlies van de omgeving. Deze bereidheid tot accepteren (WTA) kan uitgedrukt worden als:

$$W(Y_0, H_0) = W(Y_0 + WTA, H_2)$$

Het welzijn van een individu wordt voorgesteld door W, Y_0 stelt het inkomen voor in de

huidige situatie H_0 (status quo) en H_2 de situatie waarbij de toegang tot een goed of dienst ontnomen wordt.

In de context van deze studie zal er gepeild worden naar de bereidheid om een verminderde toegang tot het reservaat te accepteren. De problematiek was dat de bevolking de bufferzones betrad en zich daarbij niet hield aan de regelgeving door hun landbouwgebieden uit te breiden en o.a. hout, vruchten en beschermde planten te verzamelen uit de zones. Oorspronkelijk was de WTA-vraag geformuleerd als 'Wat bent u bereid om te accepteren als compensatie opdat u de bufferzones niet meer zou betreden?'. Eens aangekomen op het veld, bleek dat het management was gestart met de bouw van een hek om de bufferzones van de transitiezones te scheiden. Daarenboven werden de straffen voor overtredingen (zoals het betreden van de bufferzone zonder toestemming) verzwaard. Dit zorgde ervoor dat de lokale bevolking de bufferzone niet meer betrad of dit toch niet wilde toegeven. Omwille van deze reden, was het noodzakelijk om de WTA vraag aan te passen. De vraag werd nu als volgt gedefinieerd 'Wat bent u bereid om te accepteren als compensatie als de gecontroleerde landbouwzone wordt ingeperkt?'. Een inperking van deze zone impliceert een rechtstreekse uitbreiding van de beschermde zones.

Er zijn verschillende manieren om deze WTA vraag op te stellen, de literatuur stelt vier methodieken voor: (1) de open vraag (2) biedspel (3) gesloten referendum (4) gesloten referendum met opvolgvragen.

Deze 4 methodes hebben zowel voor- als nadelen. De open vraag methodiek wordt vaak gehanteerd als er geen informatie voor handen is om een startwaarde voor WTA op te stellen. Omdat er in het Pendjari reservaat beperkt onderzoek werd gevoerd, was er een noodzaak om in de pre-test fase van de survey een open vraag te stellen. Op deze manier zouden dan intervallen kunnen bepaald worden die zouden kunnen gebruikt worden om WTA te ondervragen in een gesloten format zoals (2), (3) en (4). Het grote nadeel van een open vraag is dat het voor de respondenten niet in hun voordeel is om een laag bedrag te zeggen. Een open vraag is ongelimiteerd, wat ervoor zorgt dat er vaak te hoge, onrealistische bedragen worden geopperd, enerzijds als blijk van protest tegen de maatregel en anderzijds omdat het voor sommige mensen moeilijk is om zonder concrete richtlijnen een bedrag voor te stellen. Deze moeilijkheden worden weggewerkt als de gesloten methodes gehanteerd worden. Deze zijn te vergelijken met referenda. De respondent wordt dan voor de keuze gesteld of hij een compensatie van €X zou aanvaarden voor het verlies van het goed of de dienst. De respondent heeft dan de keuze om dit aanbod te aanvaarden of te weigeren. Een nadeel is dat de informatie over het uiteindelijke WTA-bedrag eerder beperkt is. Om meer informatie omtrent de afbakening van het bedrag te verkrijgen, kunnen er opvolgvragen gesteld worden. Als de respondent het eerste bod niet aanvaardt, wordt er een hoger bod gedaan. Als de respondent het eerste bod aanvaardt, wordt er een lager bod gedaan om

te testen of de respondent dit ook als voldoende zou achten. Deze laatste aanpak is degene die het meest wordt aangeraden door NOAA panel omdat deze zou leiden tot de meest accurate resultaten. In de voorbereiding voor het veldwerk werd deze methodiek dan ook gehanteerd voor het opstellen van de WTA vraag. Omwille van de plotse verandering van beleid, moest deze vraag aangepast worden op het veld. Daarenboven waren de resultaten van de pre-test fase nu niet meer bruikbaar en moest de open vraag methodiek doorheen het hele onderzoek behouden worden. Om het aantal protestantwoorden zo laag mogelijk te houden, werden er steeds opvolgvragen gesteld om de respondent te begeleiden. Vaak gaven respondenten aan dat het moeilijk was om waarde uit te drukken in geld. Ze gaven de voorkeur om een compensatie uit te drukken in een aantal zakken maïs omdat ze de beperking van de landbouwzone vooral zagen als een oorzaak voor voedseltekort. Er werd ook gediscussieerd over mogelijke alternatieve economische activiteiten voor de bevolking. Opvallend hierbij was dat de boeren aangaven dat het voor hen erg moeilijk is om een andere activiteit uit te oefenen omdat ze er niet voor opgeleid zijn en van generatie op generatie het de traditie is om landbouw uit te oefenen. Daarentegen, werd er duidelijk dat de bevolking openstond voor andere bronnen van inkomsten, voornamelijk omdat landbouw fysiek erg belastend werd ervaren. Bovendien gaven de respondenten aan dat inkomsten van landbouw ook vaak onzeker zijn. Na twee weken onderzoek op het veld, werden de resultaten van de survey geanalyseerd om een schatting van de economische waarde van ecosysteemdiensten m.b.t. de landbouwzone op te maken. Naast de WTA vraag werd er ook informatie verzameld omtrent de socio- demografische kenmerken van de populatie. Deze informatie is belangrijk om te bepalen welke factoren een invloed uitoefenen op de grootte van een individu's WTA. De literatuur en case studies in gelijkaardige gebieden stellen enkele variabelen voor die mogelijks een invloed zouden kunnen hebben op de vraag naar compensatie. In onderstaande vergelijking worden deze variabelen weergegeven:

$$WTA(i) = f(Y(i), S(i), A(i), U(i), X(i), e(i))$$

WTA van individu i wordt gedefinieerd als een functie van inkomen Y, socio-demografische kenmerken zoals leeftijd en opleiding S, houding t.o.v. conservatie A, gebruik van de ecosysteemdiensten U, andere relevante contextuele variabelen X en ruis e. Deze variabelen werden opgenomen in de survey samen met informatie over de locatie van de activiteiten van de respondent. Deze geografische info is cruciaal om de parkafhankelijkheid van de respondenten te bepalen. Indien een respondent zijn gewassen teelde, dieren verzorgde of hout sprokkelde in de gecontroleerde zone werd dit verworven inkomen aanzien als parkafhankelijk.

Het ondervragen van inkomen in ontwikkelingslanden is niet evident, omdat het gaat om een landbouweconomie waarin de bevolking het grootste deel van hun eigen productie zelf consumeert. Om een schatting te maken van dit landbouwinkomen werd er gedetailleerde

informatie gevraagd omtrent het type gewas, het rendement, het aandeel voor zelfconsumptie en de bewerkingskosten (inclusief bemesting, pesticiden en machinegebruik). Het inkomen van veeteelt werd geschat a.d.h.v. het type dier, de marktprijs en de hoeveelheid voor bezit en verkoop. De formules gebruikt om deze bedragen te bepalen worden hieronder weergegeven.

Landbouwinkomen = inkomsten van gewassenteelt + inkomsten van veeteelt

Inkomsten van gewassenteelt = bewerkte landbouwgrond (ha) * rendement van gewas (kg/ha) * marktprijs van gewas (per kg) – bewerkingskosten

Inkomsten van veeteelt = marktprijs * (aantal dieren van soort X in bezit + aantal dieren van soort X verkocht in voorbije jaar)

Het is de bedoeling om a.d.h.v. de analyse van de verzamelde informatie te bepalen welke factoren de WTA significant beïnvloeden. Omdat er uiteindelijk gekozen werd voor de open vraag methodiek zijn er voor de WTA puntschattingen verkregen. Deze konden geanalyseerd worden a.d.h.v. een OLS multilineaire regressie. Uit de resultaten van de regressie kon worden geconcludeerd dat van alle opgenomen socio-economische en geografische factoren enkel afstand tot het gemarkeerde hek en het inkomen van gewassenteelt een significante invloed uitoefenden op het voorgestelde compensatiebedrag. Ondersteund door discussies met de lokale bevolking in het veld, bleek dat de mogelijke beperking van de landbouwzones vooral een grote impact zou hebben op de gezinnen die dichter bij de bufferzone woonden en op de gezinnen die voornamelijk afhankelijk zijn van gewassenteelt. De gezinnen die verder van de gecontroleerde zone woonden (maar nog steeds op wandelafstand), gaven aan dat zij weinig impact zouden ondervinden mocht de zone worden ingeperkt. Daarenboven kon er geen verband aangetoond worden tussen de inkomsten van veeteelt en WTA, maar wel tussen de inkomsten van gewassenteelt en WTA. Een mogelijke verklaring voor deze uitkomst is dat veeteeltinkomsten minder afhankelijk zijn van een vast gebied. Veeteelt is mobiel zolang er gebieden met water en graslanden beschikbaar zijn, terwijl gewassenteelt erg grondafhankelijk is.

Informatie omtrent de bevolkingsaantallen van de dorpen was niet beschikbaar, dus de WTA bedragen konden niet geëxtrapoleerd worden. In de mate van het mogelijke werd er een zo representatief mogelijke steekproef verzameld, zodat de resultaten de belangen van de populatie zo juist mogelijk weergeven.

De maandelijks gemiddelde WTA is 15 911 CFA. Omdat de WTA een positief scheve verdeling vertoont, is de mediaan een betere weergave van WTA, deze bedroeg 12 500 CFA maandelijks. Deze resultaten zijn samengevat in onderstaande tabel:

	mediaan	gemiddelde
WTA	**12 500 CFA (≈€19,05)**	**15 911 CFA (≈€24,25)**
WTA exclusief nulwaarden[1]	**16 667 CFA (≈€25,41)**	**18 380 CFA (≈€28,02)**

Deze resultaten moeten voorzichtig geïnterpreteerd worden, omdat de gebruikte WTA methodiek gevoelig is voor overschattingen. De waarden in bovenstaande tabel zijn de maandelijkse WTA bedragen per gezinshoofd. Deze waarden kunnen gebruikt worden om een schatting te maken voor het budget dat nodig zal zijn om de bevolking te compenseren indien de landbouwzone ¼ wordt ingeperkt. Dit compensatiebudget dient niet per se in maandelijkse bedragen te worden uitgekeerd, maar kan ook onder de vorm van een alternatieve compensatie worden gegeven. Omwille van het belang van landbouw in de regio voor voedselproductie, is het aangeraden om in te zetten op het duurzamer maken van deze activiteit. Compensatiemechanismes die de productiviteit van de bestaande landbouwoppervlaktes zouden kunnen verhogen, zouden ervoor kunnen zorgen dat de dreiging van uitbreiding van landbouwgrond naar het beschermde gebied toe wordt weggewerkt.

Verder onderzoek naar duurzame manieren om het rendement van gewassen te verhogen in een extreem klimaat kan nuttig zijn voor beleidsmakers. Deze verhoogde productiviteit zou ervoor kunnen zorgen dat gezinnen productie overhouden voor verkoop. Op deze manier zouden ze monetaire inkomsten kunnen verwerven, die op hun beurt kunnen worden ingezet om alternatieve activiteiten op te starten. Deze alternatieve inkomstenbronnen zouden de menselijke impact op het reservaat aanzienlijk kunnen verlagen.

Een kritische bedenking die beleidsmakers moeten maken bij het uitwerken van deze mechanismes is dat deze voordelen net een instroom van mensen zou kunnen veroorzaken in het gevoelige gebied. Op deze manier zouden compensatiemechanismes een averechts effect op conservatie uitoefenen.

Indien rekening gehouden wordt met de menselijke en wetenschappelijke beperkingen van de *contingent valuation* methode zouden compensatiemechanismes wel degelijk kunnen bijdragen aan de harmonie tussen sociale en ecologische systemen.

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[1] Respondenten die aangaven dat ze geen compensatie nodig hadden werden geïnterpreteerd als nulwaarden.

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List of Abbreviations

AP = African Parks

AVIGREF = Associations Villageoises de Gestion des Réserves de Faune

CENAGREF = Centre Nationale de Gestion des Réserves de Faune).

CVM = Contingent Valuation Method

DBDC = Double Bounded Dichotomous Choice

ES = Ecosystem Services

EVAMAB = Evaluation of Man and Biosphere Reserves)

FAO = Food And Agricultural Organisation

LABEF = Laboratory of Biomathematics and Forest Estimations (LABEF)

OECD = Organisation for Economic Co-operation and Development

OLS = Ordinary Least Squares

NOAA = National Oceanic and Atmospheric Administration)

NTFP = Non-Timber Forest Products

UNESCO = United Nations Educational, Scientific and Cultural Organization

WAP = W-Arly-Pendjari

WTA = Willingness to Accept

WTP = Willingness to Pay

ZOC = Zone d'Occupation Contrôlée

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I would like to thank prof. Dr. Ir. Van Passel for giving me the opportunity to do research in an international context. I am certain this has enriched my academic knowledge and perspectives on life. I am also very thankful for the guidance and support throughout the whole process, even when the field work did not always go as planned, solutions were found together.

Upon our arrival in Benin, dr. Jean Didier Akpona welcomed us with open arms. I would like to express my gratitude towards him for organising all practical details for the field work.

During the month in Benin, I was accompagnied by Charlotte, another student from the University of Antwerp and Roméo Tohoun, a local doctoral student from the university Abomey-Calavi. I am very thankful I got to share this unique experience with them. Roméo's expertise of the local population and experience on the field were a great contribution to the research. During the fieldwork it was very interesting to discuss the results with Charlotte, as this lead to new insights for both of us.

Lastly I would like to thank the people close to me, for their encouragement, specifically my mom for the unconditional support and love during my academic career at the University of Antwerp.

Thank you,
Laura Hasaers

1. Introduction

Humans are dependent on ecosystems for survival. Ecosystems provide humans with habitats, from which it is possible to collect food and water. Humans are able to live because the ecosystem purifies the air they breath and allows them to research and enjoy their surrounding environment. However, it is not limited to this, there is much more that ecosystems offer to humans. These benefits, humans obtain from ecosystems are defined as ecosystem services and were divided by the Millenium Ecosystem Assessment (2005) into four categories: supporting, provisioning, regulating and cultural services. Finding a balance between social and ecological systems can often be challenging, however crucial for the future of the planet. As humans sometimes take these services for granted, it is hard to estimate a value for these services. Research concerning this topic was conducted within the framework of the EVAMAB (Evaluation of Man and Biosphere Reserves) project. The goal of the project is to investigate the economic value of ecosystem services in Biosphere Reserves such as the Pendjari Biosphere Reserve in Benin (CEBioS, 2017). Ultimately, the aim is to support cost-benefit analyses for policy interventions. According to prior research done in the area (de Ryck, 2018), the reserves' most valued ecosystem services are food provision from agriculture, water for domestic use and tourism. An increased use of these ecosystem services (ES) could pose a threat to the biodiversity of the reserve (TEEB, 2010). According to the annual report of African Parks (2017) the reserve has been facing threats such as poaching, demographic pressure on surrounding land and exponential resource erosion. UNESCO (2017) describes Man and Biosphere Reserves as areas in which the goal is to find a balance between social and ecological systems through management practices and sustainable development (UNESCO, 2017). Different policies are being considered by the current management of the reserve to reduce the human impact. These policies include: expanding the protected area and therefore reducing the access to ES for the population, toughen penalties and raising awareness. These policies are meant to positively affect the ecological system, however the impact on human lives should not be neglected and the consequences should be carefully considered. The question remains which approach or combination of policies fits best with the values and needs of the population, whilst reaching the desired outcome for conservation.

In this paper, research was done to determine the economic value of the prioritized ES, with a focus on agricultural use, in order to suggest compensation schemes for reduced access to the reserve. The outcome of this study should be able to support cost-benefit analyses for policy interventions concerning conservation.

2. Case study

Pendjari Biosphere reserve is located in the northwest of Benin. The Pendjari National park is part of this reserve and measures 4,800 sq km. Together with W & Arley park it forms the WAP complex spread across three countries, Benin, Burkina Faso and Niger as shown in figure 1. In 1996 the WAP complex was inscribed in UNESCO World Heritage list. It is the biggest remaining intact ecosystem in the whole of West Africa (Terjanian, 2017).

Figure 1: The WAP complex
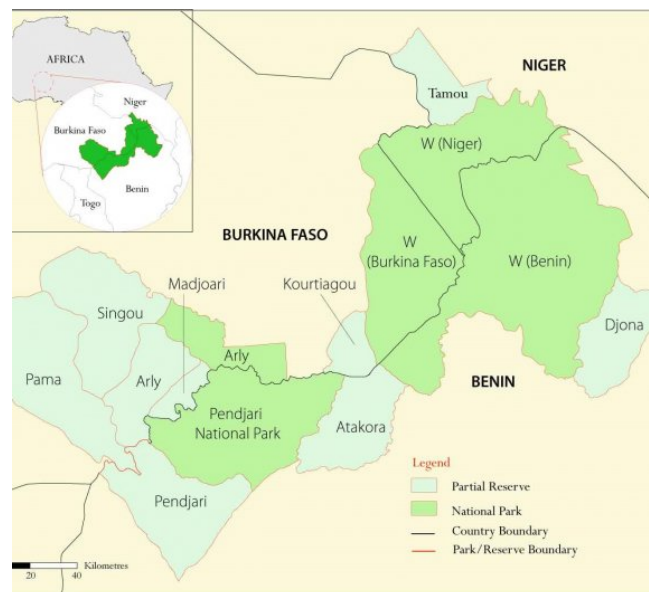
Source: SNV, 2019

Biodiversity

The park is home to endangered species including the West African lion and the region's largest remaining population of elephants. More than 460 avian species, various antelope species, cheetahs and buffalos can be found in the park. It contains important wetland, critical for the wildlife and vegetation (Terjanian, 2017). The vegetation is composed of mostly open shrub and tree savannas. (Vodouhê et al., 2009).

Climate

The climate in the region is Sudanian with a seven-month dry period. Rainfall occurs between late May and early October. The mean annual rainfall is 1000 mm (Vodouhê et al., 2009).

Management

In May 2017 African Parks took over the management of Pendjari National Park from CENAGREF (Centre Nationale de Gestion des Réserves de Faune). African Parks is a non-profit conservation organisation that currently manages 15 national parks and protected areas in nine countries (African Parks, 2019).

African Parks developed a new law enforcement strategy, introduced more patrols and invested in ranger training programs and infrastructure. A new road network was built and tourist routes were repaired. Sustainable tourism is a top priority for the Beninese government and African Parks. They invested in a lodge, safari vehicles and new tours. In 2017, the park attracted around 6000 visitors. (Terjanian, 2017). The new management wants to engage the community of people living in the 23 villages around the park. The population living around Pendjari is estimated at 40.000. African Parks claims to have a strong relationship with AVIGREF (Village Association of Faunal Reserves Management) (Terjanian, 2017). The mission of AVIGREF is to reconcile the needs of the local population with the requirements of conservation communicated by African Parks. The aim of this collaboration is to efficiently share information between the new park management and the local communities (AVIGREF, 2014). As part of their community engagement strategy, African Parks supports environmental education programs and projects for income generating activities such as honey production (Terjanian, 2017).

Zones

UNESCO defined that Biosphere reserves have to contain three interrelated zones: (1) a zone under total protection, called the core area, (2) zones surrounding the core areas, used for activities compatible with ecological practices, known as the buffer zone and (3) the transition zone, where other activities are allowed. This division of zones can be found in the Pendjari Biosphere as well. (UNESCO, 2017). In figure 2, the core areas are marked in dark green, the buffer zones are marked in orange, light green and grey, these areas are respectively used for ecotourism, protection of the central zone and game hunting. The buffer zones are designed to strengthen integrity and are managed as to minimize the human impact on the central zones (UNESCO, 2017). The transition zone consists of the controlled agricultural zone (ZOC) and the zone for exploitation of resources marked yellow and purple on the map. In the ZOC agriculture is permitted but should be done in a sustainable way so to limit the impact on the buffer zone. The park is bordered by two axes, the Tanguiéta-Porga axis and the Tanguiéta-Batia axis. Villages are located alongside these two axes and some of the villages are located within the ZOC (Idrissou et al, 2013). Although the regulations of the zones should be known by the local population, the

park is facing threats due to human impact such as poaching, illegal grazing and encroachment of agricultural land (UNESCO, 2017).

Figure 2: Protected zones in Pendjari Biosphere Reserve
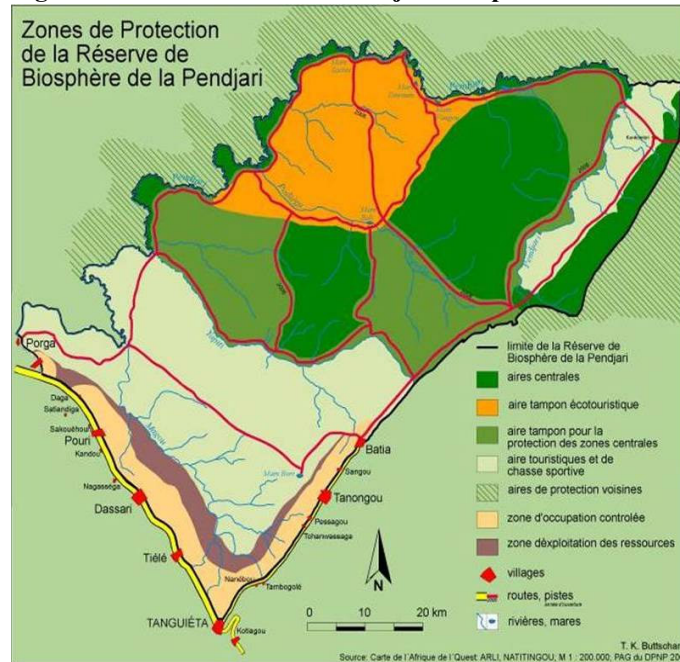
Source: Buttschardt, 2003

3. Theoretical framework

Valuation of ecosystems services – classes of values

In the context of ecosystem services passive and direct use values often coexist (Carson, 2012). Direct use values can be either consumptive, such as picking fruits and hunting or non-consumptive such as hiking or wildlife watching. In the latter, the activity doesn't reduce the stock of biological resources (NOAA, 1994). Passive use values are defined as "the values individuals place on natural resources independent of direct use of a resource by the individual. Passive use values include but are not limited to: the value of knowing the resource is available for use by family, friends, or the general public; the value derived from protecting the natural resource for its own sake; and the value of knowing that future generations will be able to use the resource" (NOAA, 1994; p. 1073). In contrary to direct use values there is no market information available for passive use values of non-market goods, this makes it a challenge to develop economic trade-offs (Carson, 2012).

To overcome this lack of information, economists turned to stated preference (SP) methods. SP methods use surveys of a representative sample of the relevant population to reveal the monetary trade off an individual is willing to make for services or goods, including passive and direct use

(Carson, 2012 & NPCC, 2018). The contingent valuation method (CVM) is the most dominant SP approach. The economic trade off or willingness to pay (WTP) value is contingent upon the nature of the constructed market described in the survey scenario (NPCC, 2018). Results from contingent valuation studies are used in cost-benefit assessments which are a useful tool for government policy interventions (Atkinson & Mourato, 2015).

Guidelines for CVM studies

Guidelines for conducting CVM studies were set up in 1993 in the U.S. by the NOAA (National Oceanic and Atmospheric Administration) panel. A panel of 22 expert economists, including Robert Solow and Kenneth Arrow. The panel of economists stated that estimates produced by well conducted CVM studies of a representative population can be treated as revealed economic behaviour (Carson & Groves, 2007). Therefore, estimates resulting from a CVM study -in accordance with the NOAA guidelines- are reliable enough to be the starting point of damage assessment, judicial processes and a tool for policy design (Carson, 2012). CVM studies have to contain a clear description of the problem and how the government is planning to address it. The quality of a CV survey and therefore the reliability of the responses is dependent on a well-defined policy proposal. The scenario must be designed in a way that respondents have enough information to make an informed decision (Carson, 2012). In addition to the WTA scenario, the survey must include questions about socio-demographics, typically the respondent's age, household size, educational level and income and finally some attitude questions concerning the respondents perceived importance of environmental quality such as conservation (FAO, 2000). As the survey design is crucial, it consists of an extensive process, including literature research, interviews with experts, pre-tests and re-adaptation. Once in the field, some key factors that contribute to the reliability of the survey responses are: in person interviews, well trained interviewers, and a well-planned sampling strategy (Carson, 2012).

Perspectives within CV

Two perspectives within contingent valuation to reveal economic behaviour are (1) willingness to pay (WTP) and (2) willingness to accept (WTA). Willingness to pay is expressed as a maximum amount people are willing to offer for a (public) good or service. Willingness to accept is expressed as the minimum amount that people expect as compensation to abandon a good or to put up with a negative situation such as environmental damage. (Johnston et al., 2017) A sound understanding of these concepts is crucial for the interviewer.

WTA has been quite a controversial concept in literature and when compared to WTP, researchers often experienced that the method produced unreliable and inaccurate answers (Whittington et al., 2016). In fact, the NOAA panel recommended in 1993 to avoid the use of WTA questions (Whittington et al, 2016). Instead, the use of WTP format was recommended in situations of both a welfare gain and loss. The underlying reason for this was that WTP produced and more realistic estimates in both cases. This discrepancy between WTA and WTP can be interpreted from a behavioural economics point of view: According to Khaneman and Tversky's (1979) prospect theory the divergence is logical because people experience losses differently from gains (Whittington et al., 2016).

The reasons for the reluctance to use WTA questions were summed up by Whittington et al. (2016). The first and foremost reason is the uncertainty in which situation WTA or WTP is more appropriate. The second reason is the low to no incentive of the respondent to answer the minimum accepted value. Finally, the last reason is the occurrence of protest and non-responses. In the following paragraph, these reasons will be discussed and suggestions on how to deal with these issues will be given.

Witthington claims the definition of the status quo condition of the individual and the reference condition are important when designing WTA questions. The framework developed by Witthington et al. (2016) explains that the WTA format should be used in the case of a welfare loss as a compensation to incur a loss as is the case in this study. The willingness to accept is then formulated as follows:

$W(Y_0, H_0) = W(Y_0 + WTA, H_2)$

W is a function of the individual's wellbeing determined by income (Y_0) and the current situation (H_0). The individual's reference condition is H_2, the status quo condition (H_0) is perceived as a gain ($H_0 - H_2 > 0$). Another important issue to tackle when trying to figure out the reference point of respondents is the phenomenon of strategic behaviour. To get reliable and accurate results from a CVM study the assumption is made that respondents are truthful in their answers and reference point (Witthington et al., 2016). Carson (2012) underlined the importance of communicating to the respondents that it is in their best interest to reveal their true preferences in the study. Witthington (2010) states that overstatement of WTA is likely when respondents expect a PES (payment for ecosystems) program to be implemented and therefore try to influence the outcome of the actual payments. On the other hand, an understatement of WTA might be given by respondents who want to assure the program will actually take place with the aim of renegotiating the compensation later in the process (Witthington, 2010). These two opposing perspectives in

strategic behaviour make it a challenge for the SP practioner to frame the WTA question in a way to gather the most truthful values. In the context of questioning WTA of private goods, an auction method is used, where all the respondents are aware of the fact that only the lowest bids will be accepted. In this situation respondents have more incentives to reveal their true minimum WTA (Witthington, 2012). However this strategy isn't as obvious in the context of SP surveys and public goods. When taking face to face interviews, as recommended by the NOAA panel for CVM studies, there is the possibility to ask follow up questions, which are very useful to identify strategic behaviour and to make sure the respondent had full understanding of the questions.

Another factor contributing to the difficulty of the interpretation of WTA statements is the familiarity with a good or service. The more knowledge the respondent has about the good, the more accurately she/he can estimate its value (Witthington, 2010).

WTA is tricky, even when having considered all issues mentioned above, there is still the ethical aspect. The idea that monetary compensation could be a trade off for a reduction in environmental quality is often perceived as unethical. Case studies show that people prefer being compensated by public goods rather than by an amount of money (Witthington, 2012). This observation adds another dimension to the difficulty of designing effective WTA questions. Money is the globally accepted medium of exchange and is therefore used in SP surveys.

Elicitation methods for WTA

There are different ways of asking respondents for their willingness to accept. The choice of elicitation method is one of the major exercises in CV studies. Presently there are four types of elicitation methods: (1) open ended questions, (2) bidding game, (3) single bounded dichotomous choice (4) double-bounded dichotomous choice (FAO, 2000).

In the open ended format respondents, are asked 'What is the least you are willing to accept for...' Asking the respondents open-ended questions about minimum compensation is unbounded (Whittington et al, 2016). This approach might sound appealing but there is a risk of missing or skewed data points due to difficulty of the respondent to answer the question (FAO, 2000).

In the bidding game format, the respondents are asked if they would accept an initial amount. The interviewer then keeps lowering this amount until the respondent declines, or in the other case keeps raising the amount until the proposed compensation is accepted. The main issue with this technique is that it suffers from a starting point bias, which implies that the inital bid value can influence the respondent. This method can only be used when doing in person interviews and is quite costly and time consuming (Steel & Soden, 1999; FAO, 2000). Lastly, the repeated questioning may annoy respondents causing them to conclude more rapidly hoping to finalize the interview (FAO, 2000).

In a single bounded dichotomous choice format, also called a referendum, the respondent is asked if he would accept €X to abandon the good. The question can also be posed in a way where the respondents is asked if he would vote in favour of the proposed policy if approval of the policy would compensate his household with €X. This amount could be in the form of lower prices of products and services, reduced taxes or a monthly allowance. The major advantage of this method is that it has been shown to be incentive compatible. Given that the respondents understand that the policy depends on the majority of votes and the respondent's own vote in itself cannot influence the policy, it is in the best interest of the respondent to tell the truth (Hoehn and Randall, 1987).

To improve WTA estimates, follow up questions can be introduced. These are called double bounded designs. To illustrate this, consider a respondent who states he is not willing to accept a monthly compensation of €10 for the proposed plan. The follow-up question might ask him if he would accept €15. If the respondent declines both amounts, it is assumed that his WTA is higher than €15. If the respondent declines the initial amount and answers "yes" to the follow-up question, it is assumed that his WTA amount falls between €10 and €15. In the case where the respondent accepts the initial payment, the bid level offered in the follow-up question will be lower than the initial bid (FAO, 2000). An advantage of double-bounded designs is that they contain more information about a respondents' preferences than the single bounded format. This could generate a substantial improvement in the statistical results of a given sample (Atkinson et al., 2015). Because of this added advantage, double-bounded dichotomous choice (DBDC) formats are prefered by researchers in recent years. Consequently, DBDC design is now the most commonly used of all four methods explained above (Atkinson et al., 2015).

4. Methodology

The bid curve

As mentioned in the guidance for SP studies by Johnston et al. (2017), information gathered from a CVM survey should be included in the analysis of an individual's WTA to examine which factors significantly influence the amount. According to several case studies and guidelines (Johnston et al., 2017; Doris and Wang, 2018; Krishna et al., 2012; Xiong and Kong, 2016), the following variables could be important factors influencing an individual's WTA: income $Y(i)$, socio demographic characteristics $S(i)$ including age and education, attitude towards conservation $A(i)$, use of the environmental asset $U(i)$ and relevant variables specific for the context $X(i)$.

The bid curve of an individual's WTA can be estimated by:

WTA(i) = f(Y(i), S(i), A(i), U(i), X(i), e(i))
(e(i) = random disturbance)

The choice of elicitation method for asking about WTA has an impact on the analysis of the results. Open ended questions result in a point estimate, which can be analysed with ordinary least squares (OLS) regression. WTA data from a referendum design are often analysed by logit or probit models (Johnston et al., 2017).

Survey design

According to Carson (2012), a key factor to success of a contingent valuation study is the design of the survey and the framing of the WTA question. The survey questions were based on recommendations found in literature (Johnston et al., 2017; Carson, 2012; Witthington, 2016) and survey questions from similar cases using the contingent valuation methodology (Vodouhê et al., 2010; Bush et al., 2013; Van Oijstaeijen, 2018; De Ryck, 2018). OECD guidelines (OECD , 2006) were considered when designing the survey. The design of the survey was done in collaboration with another student, Charlotte Fabri. The following types of questions[2] were included (the order reflects the structure of the survey): socio demographic info, geographical info, economic activity, participation in park activities, attitude towards conservation and park management, willingness to accept.

Independent variables

In developing countries, especially in rural areas, asking for monthly income is not straightforward. The most important economic activity is farming (livestock and crop farming) used for own consumption. To estimate the income variable different types of income were defined: income from self-employment, crop farming and/or livestock, from wage employment, non-timber forest products (NTFP), hunting and fishing.
In order to have a basis to compare the amount of annual income stated by the respondent, control questions were added. For crop farming, additional questions were asked about the crop type, size of agricultural land, yield and ratio for consumption. In order to be able to have a more detailed view on the income of livestock, the type and number of animals were included. In the case of

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[2] These questions are in line with the information necessary to construct the proposed WTA bid curve:
WTA(i) = f(Y(i), S(i), A(i), U(i), X(i), e(i))

NTFP, the type was asked as well. The type of crops, NTFP's and animals were defined as closed categories in order to facilitate the interview. The types were based on information retrieved from previous case studies in the area (De Ryck, 2018; Vodouhê et al. 2010).

Particularly for the income from farm activities, detailed formulas were used as a basis to calculate it. For this, market prices of crops and livestock are necessary and will be collected on the field. The total farm income is defined as: income from crop farming + income from livestock. The income from crop farming was estimated by gains from crop farming reduced by the input costs including machine use, pesticides and fertilizer:

Income from crop farming = hectares of cultivated crop land * yield of crop (kg/ha) *
market price of crop (per kg) – input costs

Income from livestock farming was calculated by the following formula:

Income from livestock = (animals in possession + animals sold previous year) * market price of animal

For each activity, geographical information was gathered, since this is relevant to the research question and crucial to determine the park dependency of the population. These questions include whether following activities were done in the ZOC: animals grazing and drinking, crop production and NTFP collection.

The respondents were also asked if they took part in park activities. AP mentioned in their annual report (Terjanian, 2017) that people from local villages are recruited as rangers or as construction workers to build new road networks for tourism purposes. As mentioned in the case study, AVIGREF is an organisation that facilitates communication between the management and the local communities. To see whether the membership in this organisation could be a relevant factor influencing the WTA, a question about the individual's relation to AVIGREF was included as well.

The attitude towards park management and towards conservation were asked by several statements using a 6 point Likert scale ranging from completely disagree to completely agree and an option for 'no opinion'. The aim of this questions is to calculate a score for these two attitudes per individual to determine whether the attitude is positive or negative. Several case studies and papers (Xiong & Kong, 2016; Bush et al., 2013; Halkos, 2013; Doris & Wang, 2018) state that

individuals with a positive attitude towards conservation are more likely to give lower estimates for WTA. By making use of Cronbachs alpha after the data gathering, it will be possible to find out if the statements measure the same variable.

Dependent variable

Lastly, the framing of the WTA question is crucial. "It's a challenge to ensure that the scenario is comprehensible, plausible, and meaningful, such that respondents are willing and able to provide valid and reliable estimates of the values attached to the change of interest" (Atkinson & Mourato, 2015 p.4). Information and context about why the potential policy would be implemented is a crucial introduction in the scenario. Before proposing the compensation scheme, the respondents were informed about the importance of biodiversity and the current threats the park was facing. When formulating the compensation scheme, a hypothetical market had to be constructed. The reason for compensation had to be clear, in this case the reason was the reduced acces to the park. At the time of designing the survey, there hadn't been communicated that the fence around the park was already being built. This created some difficulties as the perception of the local people had changed due to the policy. The question on the field had to be rephrased since the acces to the park was already reduced. Instead of asking their WTA for not entering the park's buffer zone, the WTA for reduction of the controlled agricultural zone was asked. As the protected area in the park is in the form of a V shape as shown in figure 3 and the agricultural zone is parallel with the V shape, a reduction of the agricultural zone implies an extension of the core protected zone. The payment/compensation vehicle used for the WTA was a direct sum of money (grant) to be received monthly.

As mentioned in the theoretical framework, different elicitation methods exist for asking WTA. For this study, as a start the double bounded dichotomous approach was used for estimating the WTA, since it is considered the most accurate method according to the NOAA panel (1993) and the most appropriate in the context of developing countries. Unlike in developed countries, people are used to negotiate the price of any item they purchase on the market (Witthington, 2010). The proposed DBDC design can be found in appendix II. However, due to lack of information on the income and valuation of ecosystems, the values in the proposal are fictional. The aim of the pre-test phase was to ask the WTA as an open-ended question in order to define closed-ended categories that could be used to determine the initial-and follow up bid values for the double dichotomous design. However, as will be discussed later in the paper, this format didn't succeed in the field and resulted in protest and non-responses. Due to a lack of time and limited research using CVM in the area, finally the open-ended question format needed to be used. To increase the reliability of the answers to the open-ended question, follow up questions were asked to make

sure the respondent had full understanding of the policy proposal and to identify strategic behaviour. If the respondent experienced difficulties expressing their WTA in terms of money, they were asked to estimate the needed compensation in term of bags of maize. This strategy is in line with the case study done by Shyamsundar & Kramer (1996), where poor households in Madagascar were asked to estimate their WTA in bowls of rice as a compensation for not collecting NTFP's from lands in protected areas (Witthington, 2010).

Field work

The fieldwork was organized in partnership with the Laboratory of Biomathematics and Forest Estimations (LABEF) from the University of Abomey-Calavi. The fieldwork was done by three researchers: Laura Hasaers & Charlotte Fabri, master students from the University of Antwerp and Roméo Tohoun, a doctoral student from LABEF together with one local interpretor. It is crucial to work with local researchers and interpreters since they understand their own cultural norms and have the potential to conduct more culturally sensitive SP studies (Witthington, 2010). During these three weeks, the survey was taken in 19 villages. The villages were chosen based on variety in ethnicity, distance to the park fence line and division on the two axes that border the reserve. The chosen villages are shown on figure 3, marked by the yellow pins. The fence line is indicated by the white line, the shortest distances from the villages to the fence line are marked by the red lines.

Figure 3: Sample of villages on the axes of Pendjari Biosphere Reserve
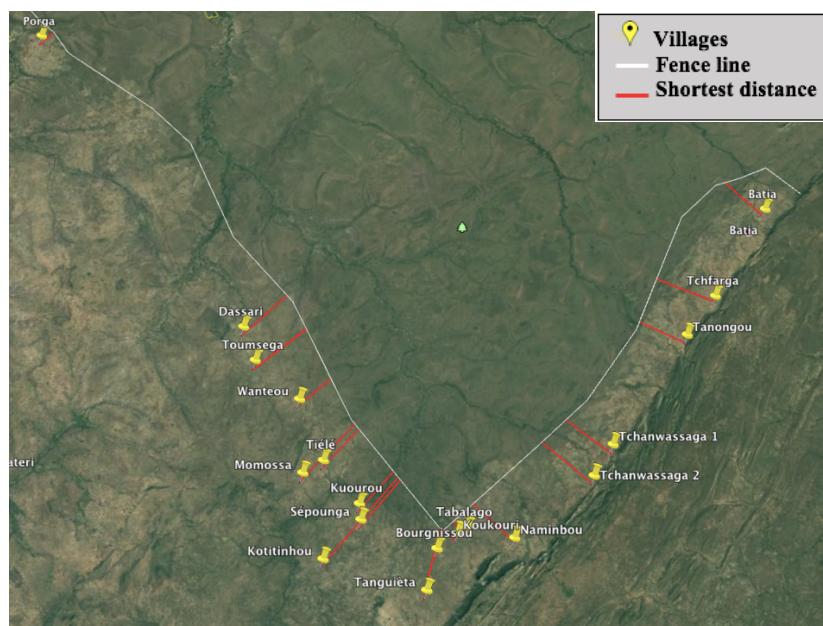
Source: Google Earth, 2019

Software

The data was collected on two tablets on which the software *Qualtrics* was installed. This digital method was preferred over paper surveys to minimize errors in the responses and to facilitate the process of collecting the data. The results from *Qualtrics* could directly be exported to *Excel*. After cleaning the raw data in *Excel*, the management of African parks made extra data available on the exact coordinates of the fence line. The coordinates of the villages were recorded during the fieldwork, therefore it was possible to calculate the exact distance from the villages to the park fence using Google Earth software. The analysis of the final dataset was done with the software *R*.

5. Results

Descriptive statistics

Data was collected from a sample of 150 respondents. Only the household heads who are responsible for the economic decisions were interviewed. Their most important socio-economic characteristics are shown in

Table **1**. More than half of the respondents (55.2%) are connected to AVIGREF, directly or through relatives. Almost one third (30.4%) takes part in park activities, these activities are in most cases construction works in the park. The sample strategy was designed in a way that an equal distribution amongst the two axes was attained. The dominant activity in the region is agriculture (95.3%), mixed farming is the most common activity. Farmers who solely focus on crop production make up 24% of the sample. Park dependent income (expressed in West African Francs 1 CFA = €0.0015) was measured by crop production, livestock keeping and NTFP collection within the park boundaries (ZOC) and employment in the park. All activities performed outside the ZOC are part of the park independent income.

Table 1: Variable statistics

Variable		n	%	Variable		n	%
Gender				**Location**			
	Female	17	11.3		Axis Tanguièta - Batia	70	46.7
	Male	133	88.7		Axis Tanguièta – Porga	65	43.3
					Tanguièta	15	10
Age groups							
	< 30	38	25.3		At < 1km from the park	118	78.7
	31– 45	44	29.3		Inside the park (ZOC)	92	61.3
	46– 60	49	32.7				
	> 60	19	12.7	**Main activity**			
					Mixed farming	102	68.0
Level of education					Crop production	36	24.0
	Illiterate	85	56.7		Livestock	5	3.3
	Primary education	41	27.3		Paid or self-employment	2	2.0
	Secondary education	21	14.0		Transformation of raw	3	2.0
	University	3	2.0		materials		
					Fishery	1	0.7
Household size							
	1 - 5	24	15.6	**Annual park-**			
	6 – 10	64	41.6	**dependent income**			
	11 – 15	40	26.0		0 CFA	28	18.9
	>15	22	14.2		1 – 200,000 CFA	21	14.2
					200,001 – 750,000 CFA	40	27.0
					750,001 – 1,500,000 CFA	29	19.6
Ethnicity					> 1,500,000 CFA	30	20.3
	Berba	97	64.7				
	Gourmantche	17	11.3	**Annual park-**			
	Waama	33	22.0	**independent income**			
	Peulh	3	2.0		0 CFA	96	64.9
					1 – 200,000 CFA	15	10.1
Involvement with the park					200,001 – 750,000 CFA	21	14.2
	Connected to AVIGREF/AP	81	55.2		750,001 – 1,500,000 CFA	12	8.1
	No connection to AVIGREF/AP	69	44.8		> 1,500,000 CFA	4	2.7
	Involved in park activities	47	30.5				

Ultimately, 16 survey results for determining the WTA were eliminated because of protest responses, such as an infinitely high bid or non-responses on the WTA question. However these results were still useful for an overview of the socio-economic characteristics in the area. In table 2 the model regressors are presented together with the way they should be interpreted. Because of the dominance of agricultural activity in the area, only agricultural income was taken into account for household income. The mean and standard deviation are given for each variable.

Table 2: Model regressors

| Variables	Description	Mean (SD)
Age	*Discrete variable in years*	42.15 (14.99)
Education	*0 if respondent has not attended school, 1 if respondent has attended primary school, 2 if respondent has attended secondary school or university*	N/A
Distance to fence line	*Distance from the respondent's village until the fence line that marks the end of the ZOC in km*	4.67 (2.32)
Participation in park activities	*0 if respondent has not participated in activities in the park (including patrolling and construction works) 1 if respondent has participated in park activities*	N/A
Attitude towards conservation	*0 if respondent has a negative attitude towards conservation, 1 if respondent has a positive attitude*	N/A
Member of AVIGREF	*0 if respondent is not a member of AVIGREF, 1 if he is member*	N/A
Household income	*Continuous variable in local currency CFA, annual income from farm activities: livestock and crop*	831754.6 (793075.9)
Crop income	*Continuous variable in local currency CFA, income from crop farming*	710457.5 (688570.1)
Livestock income	*Continuous variable in local currency CFA, income from livestock*	121297 (271988.3)

Willingness to Accept

Respondents expressed their monthly WTA for the reduction of ¼ of the controlled agricultural zone. The WTA amount was stated as a point estimate. In figure 4, the distribution of responses to the open ended WTA question is shown. The mean monthly WTA of the sample is 15911 CFA (≈€24,25), indicated by the blue line on figure 4A. Since the WTA is positively skewed, the median is a more appropriate measure of central tendency. The median of this sample is 12500 CFA (≈€19,05) marked in red on figure 4A. However, in this distribution the zero bids (meaning

that respondents expressed no need for compensation) are included. As a result, these zero values influence the mean and median of the sample. If only the WTA's higher than zero are analyzed, 17 observations have to be eliminated and the mean and median of the sample become 18380 CFA (≈€28,02) and 16667 CFA (≈€25,41) respectively marked blue and red on figure 4B. A summary of the measures of central tendency for both samples are shown in table 3.

Table 3: Measures of central tendency of WTA

	median	mean
WTA	**12 500 CFA** (≈€19,05)	**15 911 CFA** (≈€24,25)
WTA excluding zero bids	**16 667 CFA** (≈€25,41)	**18 380 CFA** (≈€28,02)

Figure 4: Histogram of WTA (in CFA)

A: all WTA bids   B: WTA excluding zero bids
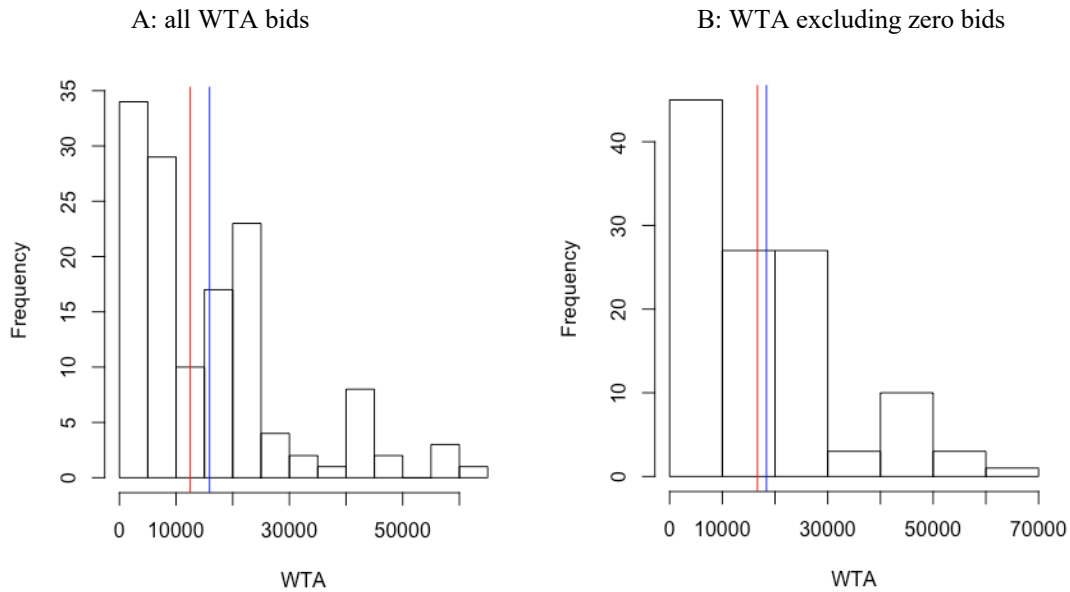
Respondents are faced with a budget constraint, determined by their income. In order to classify the WTA values in accordance to its magnitude, the magnitude is reflected as a ratio of annual WTA to annual farm income. If the ratio is between 1 and 20%, the WTA amount is considered low, 21-50% is medium and a ratio higher than 50% is considered high. The respondents who indicated that they didn't need compensation, were included in the classification as zero bids (Figure 5). This representation of categorical WTA values is meant to get a clear overview of the data and will not be used to analyse the WTA bid curve.

Figure 5: Frequency table of level of WTA
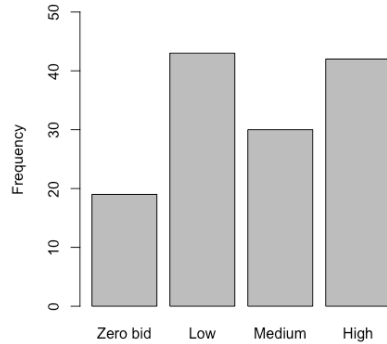
The distribution of the annual farm income, gained from crop and livestock farming is shown in Figure 6. The distribution is highly positively skewed, indicating that many households have a similar, relatively low, income and only a few households have a fairly high farm income.

Figure 6: Histogram of farm income (in CFA)
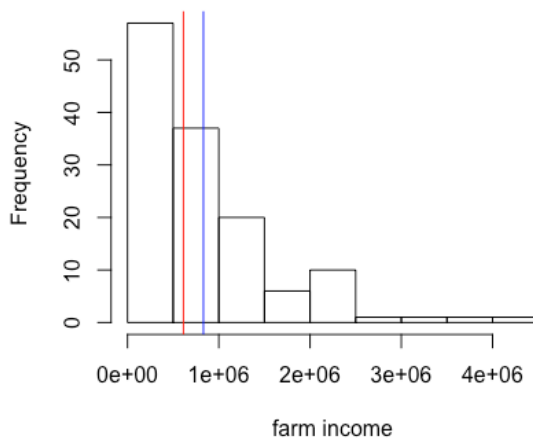
The median annual farm income for households is 612448 CFA (≈€930), the mean is 831755 CFA (≈€1268), indicated by respectively the red and the blue line on the graph. A few households have an exceptionally high farm income. These outliers were not removed from the sample because they were not based on wrong answers, since the income was checked by the control variables.

Multiple Linear Regression

The objective is to find the best fitting function for WTA, from the collected data. The data is experimental so a simple esimation method, such as OLS is sufficient for direct bid data. The regression was performed using the outcome variable "willingness to accept compensation (in CFA) for the loss of a quarter of the controlled agricultural zone". First, the baseline model which

includes all the variables recommended in literature, was tested. As shown in table 4, the regression indicates significant correlation between the outcome variable willingess to accept and the explanatory variables, distance and household income.

Table 4: Results of multiple linear regression with WTA as outcome variable

Baseline model				Improved model			
Willingness to accept	Coefficient	S.E.	P value	Willingness to accept	Coefficient	S.E.	P value
Age	-63.69	79.4	0.4242	Age	-48.4	81.09	0.5517
Primary education	-1331	2622	0.6127	Primary education	-1323	2599	0.6150
Secondary or university degree	1200	3239	0.7117	Secondary or university degree	1590	3267	0.6273
Distance	-2620	519.8	1.59e-06 ***	Distance	-2634	520.3	1.46e-06 ***
Participation	3330	2636	0.2088	Participation	3237	2639	0.2224
Attitude towards conservation	-1296	4531	0.7753	Attitude towards conservation	-1580	4543	0.7268
Member of AVIGREF	-2489	2598	0.3398	Member of AVIGREF	-2519	2599	0.3344
Household income	0.0036	0.0015	0.0148 *	**Crop income**	0,0045	0,0017	0,0103 *
				Livestock income	-0,0002	0,00043	0,.9663
Intercept	29010	6409	1.38e-05 ***	Intercept	28530	6431	2e-05 ***

F	6.044			F	5.46		
R^2	0.2789			R^2	0.2841		
R_a^2	0.2328			R_a^2	0.2321		
p	1.462e-06			p	2.586e-06		

Final model			
Willingness to accept	Coefficient	Standard error	P value
Distance	-2651	481.6	1.88e-07***
Crop income	0.0042	0.0016	0.0107*
Intercept	25300	2964	3.02-14***

F	23.02	
R^2	0.26	
R_a^2	0.2487	
p	2.713e-09	

Robustness checks

In the appendix I, robustness checks can be found, as evidence of structural validity of the regression coefficient estimates. All non-significant dependent variables were removed from the model. The effect of distance and crop income remains significant and the coefficients remain

relatively constant. To check whether the effect of crop income is robust, income is replaced by hectares of agricultural land. Hectares of agricultural land and crop income are positively correlated (0.83). The effect of agricultural land is less significant than the effect of crop income, however the effect is still in the same direction considering the small sample size of 134 respondents; a p-value of 0.0862 is not problematic. Finally, distance to the fence line was replaced with the categorical variable 'Village in ZOC'. The regression shows that the effect is significant and therefore distance is considered to be a consistent variable in explaining WTA. However, the R^2 of this model is much lower than the model that includes distance measured in km as a continuous variable. For this study the distance in km is preferred above the categorical variable since it provides more detailed information and explains more of the variance in WTA, which is useful in the context of budgeting and policy making. According to robustness checks, distance and income remain significant when deleting or substituting regressors.

6. Discussion

Literature (Doris & Wang, 2018; Krishna et al., 2012; Xiong and Kong, 2016), suggests that education could be an important factor in determining someone's willingness to accept. Generally, individuals who have a higher level of education are presumably better informed about the importance of biodiversity and conservation. Therefore, it is more likely that they will be able to estimate a realistic, substantial amount which reveals their real economic behaviour. However, the individual can still make strategic choices in order to influence the outcome of the final program. The expected decreasing effect of education on WTA, cannot be shown in this study. A potential explanation is that more highly educated people tend to leave the rural area for more developed areas to increase their job opportunities.

As mentioned before, as part of the community engagement strategy of African Parks, people living in the surrounding villages are recruited for construction works or patrolling in the park. The aim of this engagement strategy is to raise awareness of conservation amongst the people and to offer them temporary wage employment as a complementary source of income next to their farming activities. The expected effect is that this increased awareness would be related to a lower WTA in comparison with the amount expressed by people who do not participate in park activities. However, this cannot be concluded from the study. A potential explanation could be that the people working in the park are uncertain about the stability of this activity because the people are not yet familiar with the new management strategy of AP. As the main activity is construction work for tourism purposes, people had the idea their work was only needed in the start up phase. In addition to that people explained that they were not paid in time or not paid at

all for the work done in the park. This has caused some distrust of the management and therefore it is hard to determine the effect of participation in park activities on the WTA.

One would expect that a positive attitude towards conservation would be related to a lower WTA in comparison with a respondent having a negative attitude towards conservation. This relation cannot be shown by the study. A possible reason for this might be that the questions that were designed to estimate the attitude towards conservation did not really capture the essence of conservation. On average, respondents scored positive on conservation, but during the interview it became clear that respondents didn't share the same notion of conservation as the researchers did. One of the statements to measure conservation attitude was 'the existence of the park is good for the surrounding inhabitants'. The aim of this statement was to capture the passive use value as defined in the theoretical framework. However, respondents indicated more direct use values of the park such as water provision for livestock and fruit trees for food. These direct benefits do not necessarily relate to a positive attitude towards conservation, but more to the exploitation of natural resources.

AVIGREF is an organisation that has to facilitate the communication between park management and the local population. New rules and policies set by the park management are communicated towards AVIGREF members first. One would expect that a member of AVIGREF with more knowledge and information about the policies is able to make a more informed decision, resulting in a more realistic, lower WTA in comparison with people who have no direct affiliation with AP. This conclusion cannot be drawn from the study. A potential explanation for this is that the relationship between AVIGREF and the park management has drastically changed according to the respondents. They indicated that when the former park management (CENAGREF) was in charge, AVIGREF members had more power and received more benefits. They were able to buy meat from game hunting at a lower price and they were able to collect NTFP in the park without supervision. Since AP took over the management, these rules have been adapted. The price of meat from game hunting was made equal for the whole population and NTFP could only be collected in the park with permission of AP itself. This change has created some tension and confusion amongst the AVIGREF members, explaining the difficulty to show the influence of an AVIGREF membership on the WTA.

Household income has a significant positive effect on the WTA. The parameter estimate however is rather small. This is partly due to the local currency used (1 West African Franc = 0,0015 euro).

Only farm income was considered for the variable household income, since farm activities are the predominant activity in the study area.

A higher farm income is related with a higher WTA, this could be because people who are highly dependent on agriculture for their income will be more affected by a reduction of the controlled agricultural zone. It is interesting to see whether there is a difference in WTA for farmers whose income is mostly dependent on crop farming on one hand or on livestock on the other hand. This is why in model 2, the income variable is split up in income from livestock and income from crops.

An interesting conclusion that can be drawn from the second model is that livestock income is not significant in relation to WTA. This could imply that farmers that own more animals, and therefore generate more income, do not have interest in asking for a higher compensation. Whereas income generated from crop farming significantly relates to a higher WTA. This conclusion can be supported by the qualitative discussion held with the respondents. Livestock farmers tend to be more mobile than crop farmers who are attached to their agricultural land, fixed in one place. The WTA for reducing the agricultural zone was asked, this implies a direct reduction of arable land and therefore crop production. Whereas livestock farmers are able to move their livestock, as long as there is access to water and grazing land.

As mentioned in de Ryck's study (2018), food provision from agriculture and more particular crop farming was considered the most important ecosystem service of the park. The results of this regression are in line with that conclusion.

Lastly, distance is the parameter most significantly correlated to WTA. The further an individual lives from the fence line, the lower his need for compensation. For every km an individual is living away from the fence line, the WTA decreases with 2620 CFA in the first model and with 2634 CFA in the second model. The maximum distance from the village to the fence line is 10.7 km, the closest village is located 1.1 km from the fence line. The fact that distance is such an important factor contributing to the WTA is very useful knowledge for policy design. During the interview the respondents pointed out that they did not feel like they would be personally affected by the approachment of the fence, they were indifferent about the situation. The people living further away from the fence indicated that they sometimes go to the ZOC but mainly for visiting others, rather than making use of the resources within the ZOC. Respondents claim that there is enough space for agriculture and livestock outside the zone, water bassins are provided as well, so there is no need to go to the ZOC to perform their primary and secondary activities.

The opinion of the local population about the installation of the fence varied. The main issue indicated by the respondents was the confusion about the underlying reason to build the fence. There was uncertainty about the fence being built to protect the animals from humans or to protect the humans from the animals. In the field there was a consensus that AP performed better in conservation than CENAGREF. The rules to enter the buffer zone and punishments for poachers became stricter than before, people didn't take the risk anymore of entering the restricted areas and hunt illegally. The respondents noted that as a result the animals are less afraid of humans and come closer to the populated areas. Some respondents experience this as a positive consequence, as they get to see wildlife up close and get to connect with the natural environment in an authentic way. On the other hand, respondents indicated that the animals now are destroying their agricultural fields and therefore significantly reducing their crop yields. Whether a fence is the best way to protect an area is controversial. However, one thing is certain, fencing can alter ecosystems and limit the natural flow of wildlife (Wildlife Conservation Society, 2014). Pendjari is one of the reserves that is part of the Man and Biosphere (MAB) program of UNESCO, aiming to improve the relationship between people and their environments (UNESCO, 2015). Fencing is not in line with the vision of the organisation, as the purpose of the program is to encourage harmonious integration of humans and nature (UNESCO, 2015). The social and ecological systems should strengthen each other. According to UNESCO, this should be achieved by sustainable development supported by innovative combinations of economic and environmental approaches.

At the time of the field work, only the poles were installed that mark the end of the agricultural zone. Rangers were used to control human activity close to the border. As described earlier in this paper, the reserve is split up in different zones, the core area, the buffer zone and the transition zone. This division of zones characterises Biosphere Reserves, as they help to improve biodiversity and promote sustainable development for society. However, according to the respondents these zones are not always clear and this is potentially why agricultural land sometimes crosses the transition zone. Assuming that the vagueness about the zones is the main issue, clear marks such as poles can be part of the solution. Additionally, rangers that intervene when necesarry and solutions to protect crop fields should be able to fulfill the same purpose as an actual fence (Ogden, 2014).

7. Implications for Policy Design

The purpose of this case study was to find out the economic value of the prioritized ecosystem services in the reserve through research about potential compensation for reduced access to the reserve. The regression results show that an individual's WTA is influenced most by the distance

from their home to the fence line. The influence of crop income is significant but rather small, however, an important conclusion to be made is that the biggest concern of the farmers was their potential loss of agricultural land and therefore a shortage of food supply. It is recommended to design a policy for which different compensation schemes are worked out related to the farmers' distance to the fence and his crop revenue. To be able to implement effective policies for reducing the human impact and pressure on surrounding land, that do not compromise the welfare of the surrounding local villages, one needs to understand the actual needs and values of the surrounding population. In an agricultural economy, where people produce only for self-consumption, organisations should keep in mind that creating awareness about biodiversity will not directly influence the behaviour of farmers. According to Postmaterialist values thesis (Inglehart, 1977) concern for the environment emerges if basic material needs and political security are met (McCright et al., 2016). This hypothesis supports the phenomenon that conservation programs are often hard to succeed in developing countries.

African Parks (2017) and UNESCO (2017) state that encroachment of agricultural land is one of the major threats to the park. The expansion of agricultural land is a trend in Sub-Saharan Africa, including Benin. Agricultural areas progressed from 9.2 to 27.1 percent of the total country area between 1975 and 2013 (CILSS, 2016). This expansion of agricultural land in Benin is due to (1) increase in population which in turn increases the demand for food crops and (2) degradation of soil (CILSS, 2016). When designing policies for compensation, the core issue should be tackled first. Instead of focussing on raising awareness about conservation as a main tool to reduce human impact on the ecosystem, policy makers should concentrate more on the main use of the ecosystem, which in this case is agriculture. The policy should be designed so to limit the consequences of agriculture, core to the life of the people in the surrounding villages. In line with findings in the field and in literature (Saïdou et al., 2004 ; Pretty J.N. et al., 2006) it is recommended to invest in increase of productivity of the existing agricultural areas to pursuit sustainable development. The calculated budget for this strategy can be based on the estimated WTA values from the regression model. The use of fertilizers and specific tools is rather limited in the area. During the discussion in the field, the observation was made that most respondents who used fertilizers were obliged to do so by the government because they were farming cotton. The respondents used part of this fertilizer meant for cotton production for their food crops as well. However, this isn't a sustainable strategy in the long term. This is why it is recommended to compensate the population with tools and infrastructure specific to the food crops they are producing, as well as promoting high-yielding crop varieties (Saïdou et al., 2004). Another method that has been successful in a similar area is more efficient water use, increasing soil

fertility and thus productivity (Pretty J.N. et al., 2006). Further research must be done to find more sustainable ways of increasing the crop yield in the area. Maize is the main produced food crop in the area (cultivated by 90% of the sample respondents) and the main component of their daily diet. Respondents were more willing to state their compensation in terms of bags of maize than in a monetary term because they perceived the reduction of the ZOC as a major threat to food shortage. If the production of maize can be increased by increasing the yield (using the right tools and expertise) instead of expanding the land, it might even be possible for the households to generate overproduction, which can then be sold on the market. This could be a way for them to enter a monetary economy, in which they are able to start up other activities or pay for education in order to reduce the dependency on agriculture. The rise of productivity of existing land and the possibility of generating other economic activities, independent from the reserve, could significantly reduce the human impact and pressure on the protected area.

This leads to the final policy recommendation: the creation of alternative activities. In the past, AP has taken initiatives to introduce beekeeping, fish tanks and livestock drink reservoirs in the local communities. However, observations in the field did not show success of these initiatives. Local population complained about half finished projects and local investments without return. A clear overview of the plans and developments of these initiatives taken by AP is needed to make a comprehensive assessment of the potential successful alternative sources of income. During the interviews, respondents indicated that they were willing to give up a part of their agricultural activity if they were able to generate income from another activity which is less physically exhausting. Alternative activities proposed by the local population are apiculture, aquaculture, guiding tourists and most importantly farming livestock. Many of the respondents indicated that without proper education, there is no other way for them to generate income except from farming. Knowledge about farming is transferred from generation to generation, in contrast to the other proposed activities for which education is necessary. The benefits of livestock farming relative to crop farming were pointed out by the population: the mobility, the fact that livestock is less season-dependent and physically less tough than crop farming. The downsides that were mentioned were risk of disease outbreaks and theft. Infrastructure and vaccines for livestock could be another way of compensating the population for reducing the agricultural zone. An added benefit of vaccines is that the diseases will not spread to the protected wildlife and is therefore beneficial for conservation. The livestock is fed by crops from the agricultural land, so providing livestock feed could also be an alternative strategy to reduce the impact of crop farming.

A critical note to these findings is that working out compensation schemes in terms of money, increased productivity or alternative activities is that they should be conducted with care. The main purpose of these schemes is to limit human impact and generate sustainable development in line with conservation goals. One should be aware of that compensation schemes might attract outsiders hoping for benefits ultimatlely increasing the population in the sensitive area. This may reverse any potential effects the compensation may have. (Upadhyay, 2013)

8. Limitations to the study

The absolute value of the estimated WTA should be interpreted with caution, since it was stated as an open-ended question, due to limited time in the field. As mentioned in the theoretical framework, it is not recommended to ask for WTA in this format because it is more sensitive to overstatements and protest responses. The time to take the surveys was underestimated, it took around 50 minutes per respondent to complete the full survey, which resulted in 150 respondents in 14 days. It is recommended to increase this number to gather a more representative sample of the population. Next to this, the pure randomness of selection could be questioned. Official lists with statistics from each village, from which to draw a random sample were not available and most of the people interviewed were introduced by the head of the village. The research was done in a relatively small area, which increases the likelihood that people talk about the survey questions and influence each other.

A pre-test had been conducted in order to make sure the survey was understandable for every educational level. However, the WTA question was rather difficult for the respondents to answer, since they were not used to think in monetary terms and experienced difficulty with imagining hypothetical scenarios. They preferred answering in terms of bags of maize, the most consumed and produced food crop. Further research should be done to find a way of asking about WTA in other terms than money. Food crops could be an alternative, however, the market price is not stable and could produce inconsistent answers. Lastly, the reference condition of the respondents was not consistent, not all of the respondents were already confronted with the installation of the fence, since it was just the beginning of the construction process and the poles were not yet installed along the whole length of the border. This could have influenced their estimate of WTA as well. That is why it might be interesting to redo this study a few years after the completion of the fence (or alternative solution) and compare the difference in welfare and attitude towards park management and conservation.

Lastly, as described in the theoretical framework, WTA remains a challenging method to reveal preferences and economic behaviour. The method is still considered controversial and only

limited research has been done to improve the reliability and truthfulness of respondents' answers to WTA questions. For future research, it is recommended to investigate the economic value of ecosystem services from two perspectives: the WTA and the WTP methodology. One could formulate the statement as 'what would you be willing to pay in cash or in labour to restore the degraded land due to agricultural use'? If both WTA and WTP questions are asked in order to obtain the value of ecosystem services, the researcher is able to look at the discrepancy between WTA and WTP analyse this difference in order to obtain a more realistic and interval estimate for the true economic value of the ecosystem.

9. Conclusion

The aim of this research was to find the economic value of the prioritized ecosystem services provided by Pendjari Biosphere Reserve and more specifically by the ZOC. Through CV study, data was collected on the willingness to accept a reduced access to the reserve. Results of the survey indicate that the ZOC is valued highly amongst the local population, especially by those living close to the fence line and active in crop farming. The sample means can be used as a basis for cost-benefit analysis in policy making. However, since closed-ended WTA formats tend to generate more reliable results, additional research on this topic is recommended. The data gathered in this study can be used as a basis to design a referendum WTA format.

Finally, the findings of this study show that the population relies heavily on crop farming for their income and that a potential shortage of food is their biggest concern if the ZOC gets reduced. This is why policy makers should design compensation schemes that encourage sustainable development, contributing to both the welfare of the local population and conservation of nature. Instead of proposing a monthly allowance as compensation, alternative schemes must be considered. This alternative approach must address the populations' biggest concern, being food shortage. The two alternatives proposed by this study are (1) innovative solutions to increase farm productivity and (2) funding of alternative activities resulting in additional sources of income.

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11. Appendix

I. Robustness checks

Final model: Removing all non-significant variables
Robustness check 1: Replacing distance by living in ZOC (0 or 1)
Robustness check 2: Replacing income by arable land (hectares)

Final model			
Willingness to accept	**Coefficient**	**Standard error**	**P value**
Distance	-2651	481.6	1.88e-07***
Crop income	0.0042	0.0016	0.0107*
Intercept	25300	2964	3.02-14***

F	23.02
R^2	0.26
R_a^2	0.2487
p	2.713e-09

Check 1				Check 2			
Willingness to accept	**Coefficient**	**Standard error**	**P value**	**Willingness to accept**	**Coefficient**	**Standard error**	**P value**
Village in ZOC	8165	2377	0.000795***	Distance	-2723.2	492.2	1.65e-07 ***
Crop income	0.0054	0.0017	0.001778 **	Agricultural land	491.7	284.4	0.0862
Village in ZOC	8165	2377	0.000795***	Intercept	25966.5	3234	4.93e-13***

F	13.01			F	20.29		
R^2	0.1657			R^2	0.2365		
R_a^2	0.1529			R_a^2	0.2249		
p	7.034e-06			p	2.107e-08		

II. Survey

I.	*Personal characteristics*
1.	Are you the household head? Yes / No
2.	Which gender are you? Male / Female
3.	What is your age?
4.	What is your highest level of education? Illiterate / No formal education / Primary school / Secondary school / University
5.	Which ethnic group do you belong to? Berba / Gourmantché / Waama / Peulh / Other
6.	What is your household size?

II.	*Spatial variables*
7.	In which village do you live?
8.	Do you live inside the Zone d'Occupation Contrôlée?
9.	What is the distance from your home to the controlled access zone (in kilometres)?
10	What is the distance from your home to the buffer zone (in kilometres)?

III.	*Economic characteristics*
11.	What is your **main** occupation/profession? What is your secondary activity? - Fisheries sector - Crop farming - Livestock keeping - Petty trade - Transformation of raw materials - Self-employment in the non-farm sector (e.g. barbers, tailors, etc) - Wage employment (e.g. government officials or employment by an NGO/private company)
12.	What is your average annual income (in West African CFA)?
13.	For how much of this income (in West African CFA) are you dependent on Pendjari?
14.	What are your sources of income? - Income from crop farming/planted fruit trees - Income from livestock keeping - Income from hunting - Income from fishing - Income from self-employment and/or wage employment - NTFP income (e.g. firewood, construction wood, locally brewed drinks, mustard, etc.) - Others
15.	If they answered 'crop farming' to Q14: How much of the following crops (in kilograms) do you sell per year? Fill in the table below.

	Planted surface (ha)		Yield (kg/ha)	Portion consumed	Portion sold
	Inside ZOC	Outside ZOC			
Corn					
Cotton					
Rice					
Sorghum					
Yam					
Peanuts					
Soy					
Other					

16.	If they answered 'livestock keeping' to Q14:

How many of the following animals do you own, and do you sell per year? Fill in the table below.

	Nr. animals you currently own	Nr. animals you sell per year
Sheep		
Goats		
Dogs		
Rabbits		
Pigs		
Cows		
Ducks		
Guineafowl		
Chickens		

17.	Where do these animals graze and drink? In the *ZOC* / Outside the park
18.	If they answered 'fishing' to Q14: How many kilograms of fish do you sell per year?
19.	If they answer 'self-employment and/or wage employment' to Q14: How much do you earn per year from self-employment and/or wage employment?
20.	If they answer income from NTFP to Q14: Which types of the following NTFP do you sell per year? And how much do you earn from this per year (in West-African CFA)?

- Firewood: …
- Wild foods: …
- Medicinal plants: …
- Forage: …
- Shea butter: …
- Sesame oil: …
- Neem oil: …
- Local drinks: …
- Others: …

21.	How much do you spend on farm inputs every year (e.g. fertilizers, labour, etc.)?

IV.	*Study-specific information*						
	Perception towards park management	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No opinion
22.	There is good cooperation with African Parks for protected area management						
23.	African Parks discusses/gets opinions from local communities						
24.	African Parks shares their latest information with the local people						
25.	African Parks, the current park management, is better than CENAGREF, the former park managers.						

	Perception on conservation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No opinion
26.	Wildlife should be conserved for future generations						
27.	Hunting should not be allowed inside the park						
28.	People who poach should be punished						
29.	It is a good thing that a fence is being placed to protect the park from human deterioration						
30.	It is important to protect plants and trees in the park						
31.	The existence of the park is good for the surrounding inhabitants						

32.	Is someone close to you member of AVIGREF/African Parks? Yes / No (Who?)
33.	AVIGREF or African Parks? AVIGREF / African Parks
34.	Are you involved in park activities (e.g. tourism, conservation, maintenance, etc.)? Yes / No
35.	Which resources from the controlled access zone do you use? And what is their importance? Divide 100 points between the resources according to their importance. • Livestock grazing • Arable land • Water • Timber/firewood/charcoal • Hunting • Ceremony site • NTFPs • Others

36.	WTA question V1: **This question is only applicable for respondents who enter the buffer zone (excluding the ZOC) and make use of the zone's resources for their income.** Situation sketch

In order to enhance and protect the wildlife and biodiversity of Pendjari National Park, the management is thinking about implementing new policies to limit the use of resources and agricultural activities in the protected areas.

Suppose it will not be possible to enter the Pendjari National Park buffer zone (excluding ZOC) anymore.

What is the minimum amount of monetary aid you would be willing to accept to compensate for income loss? (open question)

Alternative to WTA question after pretest phase

Start with an open question in the pretest phase, to get an understanding of what the range of values of WTA are. After collecting the answers to this open-ended question, a scale of values can be estimated. These values can be used to transform the WTA question into a closed ended question, using the double-bounded dichotomous choice (DBDC) model. This elicitation format consists of asking respondents two dichotomous choice questions. First, participants are asked if they are willing to accept a specific bid amount and then face a second question involving another bid, higher or lower depending on the response to the first question. The DBDC approach has been shown to be statistically more efficient than a single bounded approach.

In this DBDC model, we would ask the respondent the following:

Suppose the Pendjari National Park provides monetary aid of X West African Franc a month (*value deducted from open end question*) to compensate the income loss you would have (from agricultural activities/resources) if you would not be able to enter the buffer zone (excluding ZOC) anymore. Would you be willing to accept ? YES/NO

- If YES: ask respondent if he/she is willing to accept a lower value (range of values deducted from answers to open question)
  - If YES, possibility to propose even lower compensation in smaller steps of 500 CFA to calculate the amount as precise as possible
  - If NO, possibility to propose a higher compensation in smaller steps of 500 CFA to calculate the amount as precise as possible
- If NO: ask respondent if he/she is willing to accept a higher value (range of values deducted from answers to open question)
  - If YES, possibility to propose lower compensation in smaller steps of 500 CFA to calculate the amount as precise as possible
- If NO, possibility to propose a higher compensation in smaller steps of 500 CFA to calculate the amount as precise as possible
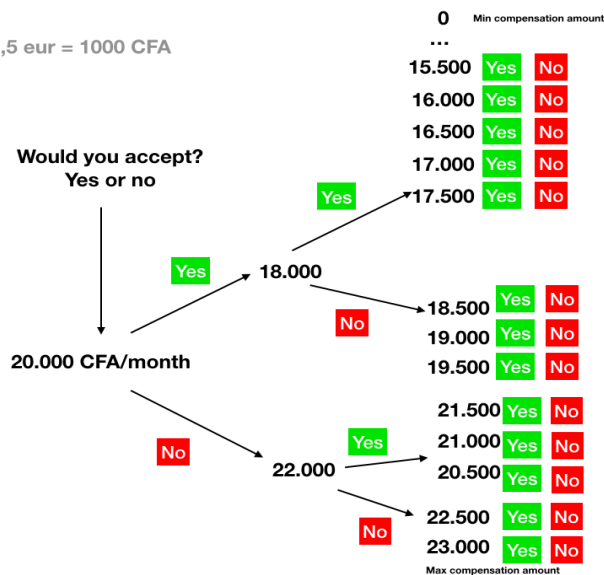
Note that all values in this representation are fictitious, the real values and intervals used on the field will be determined by the open question in the pretest phase

Reasons for not accepting an amount:

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WTA question V2 (after receiving information about the construction of the fence)

The Biosphere Reserve is one of the biggest intact ecosystems in West Africa, it offers benefits for humans and animals. However, the in order to make sure these benefits are still there for future generations, it is important to efficiently use the resources provided by nature. Suppose that the ZOC will be reduced with ¼ , (meaning the fence will approach) in order to limit its negative impact on the buffer zone. What would you be willing to accept for this loss?

In this scenario we asked to all respondents what they needed as compensation for the ¼ loss of the ZOC. This relative measure was chosen, because the ZOC does not have the same width for every village. We also considered asking every respondent: 'What if the fence approached with one km?' However this would lead to more difficult responses to interpret, whereas a relative measure captures the same essence. In order to help the respondents with their thoughts, we always made an estimation of the distance the fence would approach by.