

IMPLICATIONS OF WATER TARIFF STRUCTURE ON WATER DEMAND IN SANTA CRUZ ISLAND (GALÁPAGOS)

By: Maria Reyes, MSc.

m.reyesperez@unesco-ihe.org

Presentation Structure

- 1) General Information
- 2) Problem Description
- 3) Objective
- 4) Methodology
- 5) Results
 - Average costs of water supply in Santa Cruz
 - Analysis on willingness to pay and different tariff structures
 - Scenarios
- 6) Conclusions
- 7) Further Research

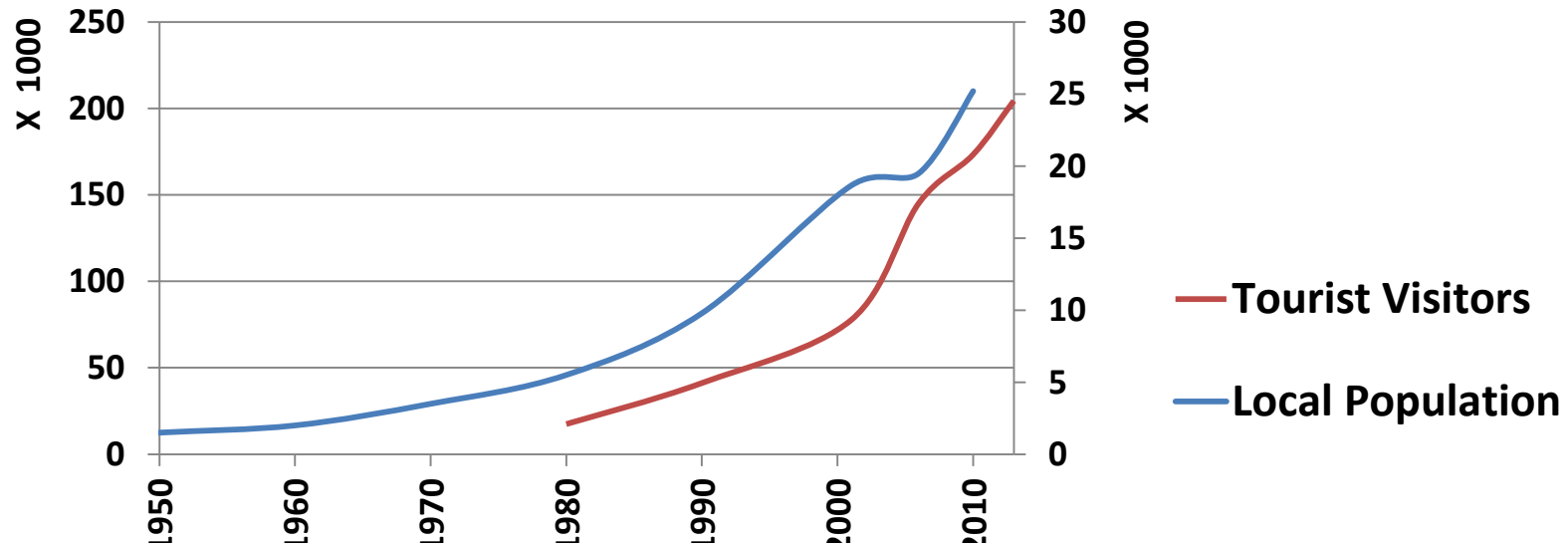
- Located 600 miles off the coast of Ecuador (South America)



Presentation Structure

- 1) General Information
- 2) Problem Description
- 3) Objective
- 4) Methodology
- 5) Results
- 6) Conclusions
 - Average costs of water supply in Santa Cruz
 - Analysis on willingness to pay and different tariff structures
 - Scenarios
- 7) Further Research

Exponential population growth (INEC, 2010)

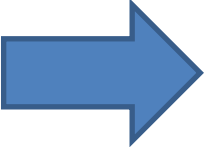


Source: DPNG, 2013

Unreliable and intermittent systems

Brackish-
contaminated
Water (Liu, 2010)

Intermittent
supply



**Different
Tariff
Structures**

**No metering
(Pto Ayora)**



Water Supply (different sources)

1. Municipal supply

- Puerto Ayora
- Bellavista



2. Private pumping (crevices in P. Ayora)

→trucks (Bellavista)



Crevice “Mision Franciscana”



Crevice “Ingala”



3. Bottled water (6 desalination companies)



Aqua Galápagos



Ofrecemos: botellones, galones, 2 litros, 5 litros, botellitas 50cc, y agua al granel

Horario de atención: 07:30 a 12:30pm y 14:30 a 17:00

SERVICIO A DOMICILIO SIN COSTO

Tomas de Berlanga y 12 de Febrero
@www.villavolcan.com

Puerto Ayora - Isla Santa Cruz - Galápagos

2526 033 - 0998 276515



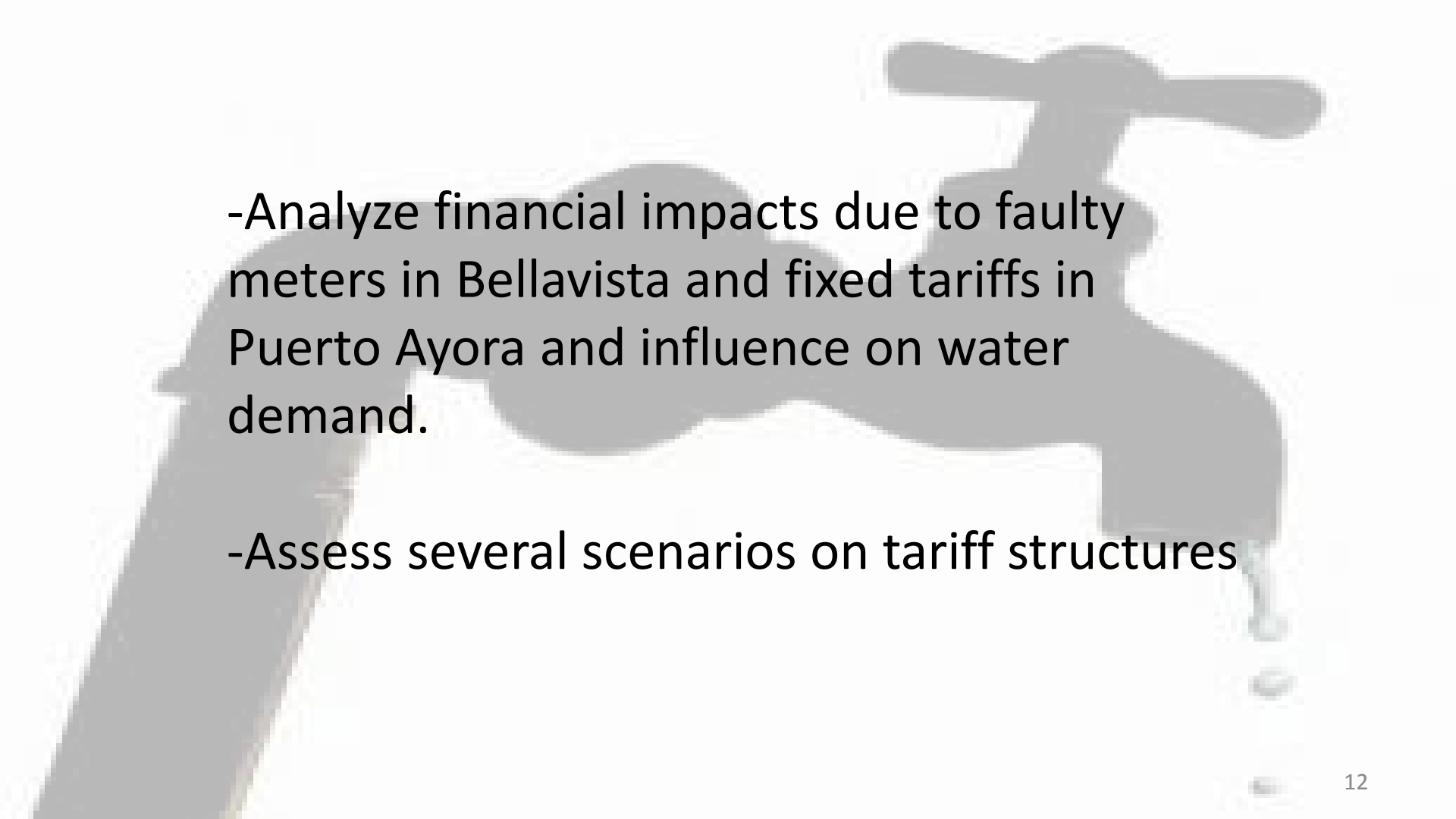
Water Tariffs

- Fixed monthly tariffs in Puerto Ayora
- Consumption-based tariffs in Bellavista
 - 1.21 USD/m³

Category	Number of connections*	Fixed Value (USD)
Domestic (less than 100 m ² of area)	1146	5.24
Commercial	932	11.24
Industrial (Big hotels and laundries)	21	45
Residential (small hotels)	20	28.50
Official	28	6.12

Presentation Structure

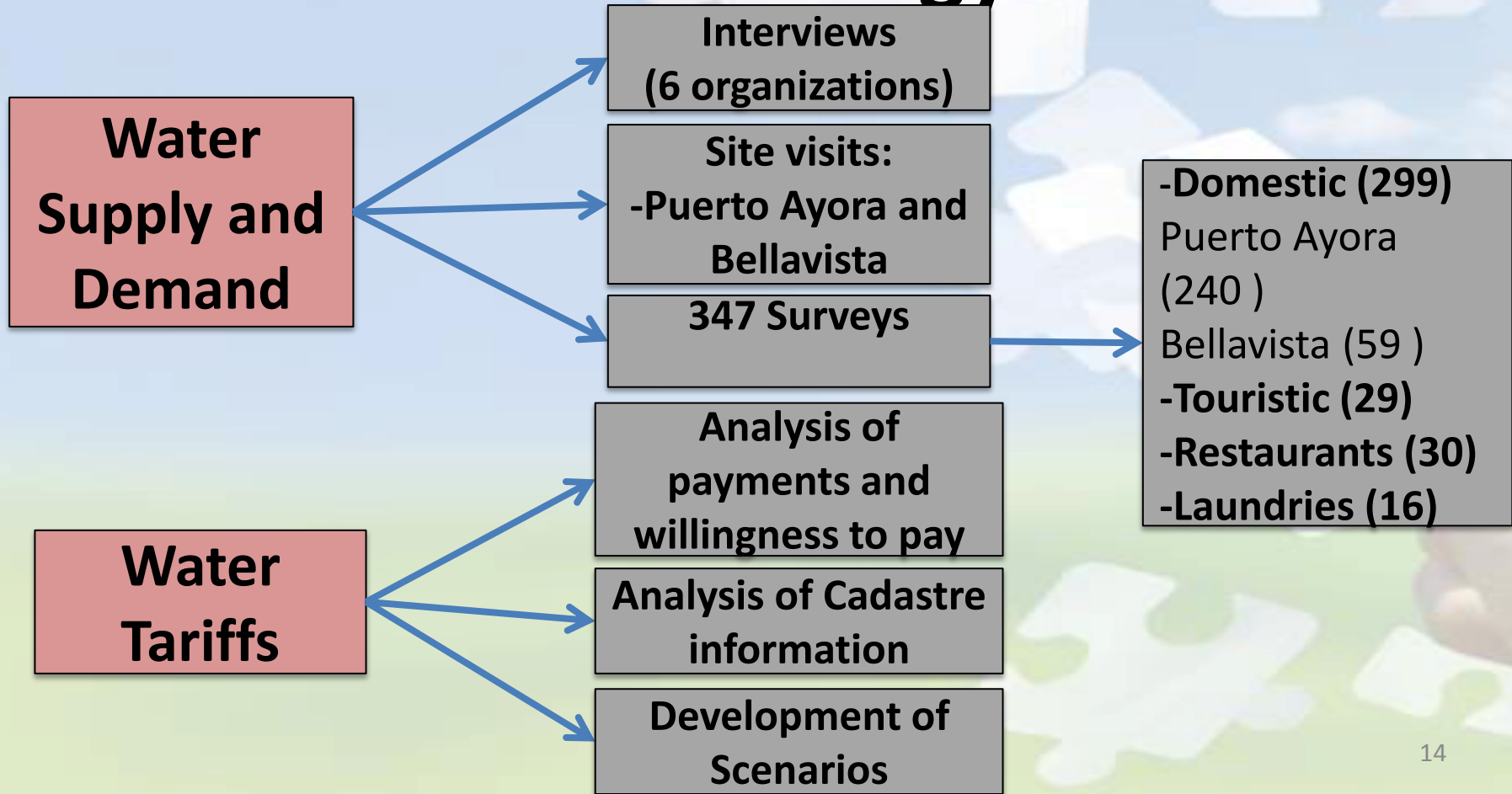
- 1) General Information
- 2) Problem Description
- 3) Objective
- 4) Methodology
- 5) Results
- 6) Conclusions
 - Average costs of water supply in Santa Cruz
 - Analysis on willingness to pay and different tariff structures
 - Scenarios
- 7) Further Research

- 
- Analyze financial impacts due to faulty meters in Bellavista and fixed tariffs in Puerto Ayora and influence on water demand.
 - Assess several scenarios on tariff structures

Presentation Structure

- 1) General Information
- 2) Problem Description
- 3) Objective
- 4) Methodology
- 5) Results
- 6) Conclusions
 - Water Supply
 - Water Demand
- 7) Further Research

Methodology



Presentation Structure

1) General Information

2) Problem Description

3) Objective

4) Methodology

5) Results

- Average costs of water supply in Santa Cruz
- Analysis on willingness to pay and different tariff structures
- Scenarios

6) Conclusions

7) Further Research

Average costs of water supply in Puerto Ayora

Category	Average number of connections	Fixed Value (USD)	Average revenue (USD/year)	Average demand per premise (m ³ /month)	Average cost of water (USD/m ³)
Domestic (< 100 m ²)	1146	5.24	5, 716	16.2	0.31
Domestic (>100 m ²)	886	11.24	10, 275	18	0.61
Commercial (restaurants)	49	45	162	42.4	0.26
Small hotels	21	28.50	917	182.9	0.24
Big hotels	20	6.12	558	235	0.12

Average costs of water supply in Bellavista

Month	Registered Consumption (m ³)	No. of non-working meters	Average demand/premise (m ³)	Total billed (USD)	Price of water (USD/m ³)
January	5,376	79	15	6,931	1,05
February	5,370	83	16	6,926	1,04
March**	330	404	13	829	0,15
April**	441	407	37	952	0,06
May	4,605	71	13	6,002	1,09
June	6,513	72	18	8,313	1,06
July	6,262	80	18	8010	1,04
August	5,559	82	16	7,160	1,04
September	5,654	89	16	7,277	1,02
October	5,654	90	16	7,278	1,02
November	5,098	88	14	6,608	1,04
December	4,965	87	14	6,450	1,04
AVERAGE	5,506	82	16	7096	1,05

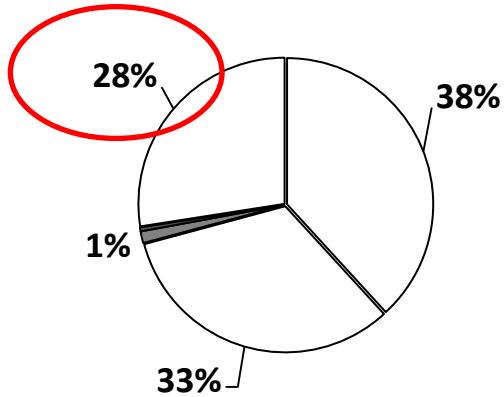
Payment of Tariffs

□ 5.24 USD

□ 11.22 USD

■ 28.5 USD

■ 45 USD



← Puerto Ayora

■ 5 to 10 USD

■ 11 to 15 USD

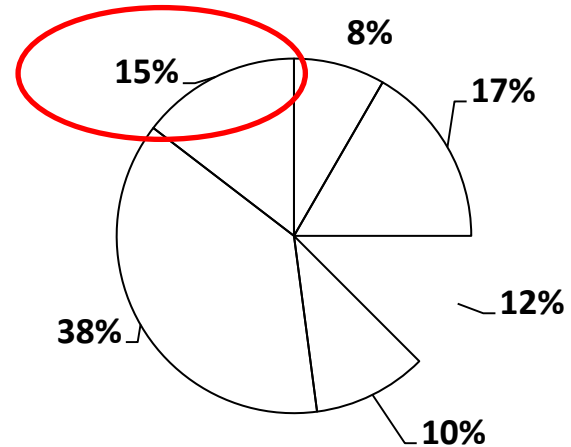
† 16 to 20 USD

▨ 21 to 25 USD

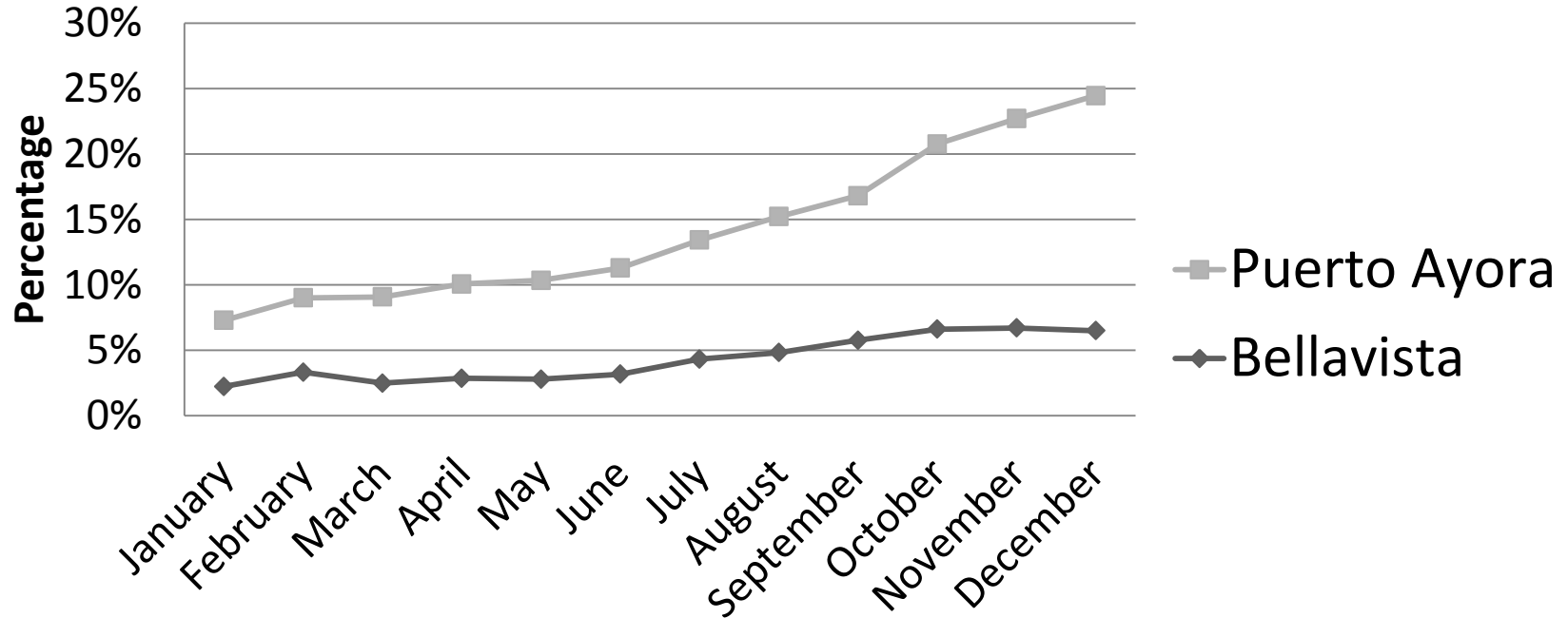
□ Above 25 USD

▩ No payment

Bellavista →



Analysis of overdue bills



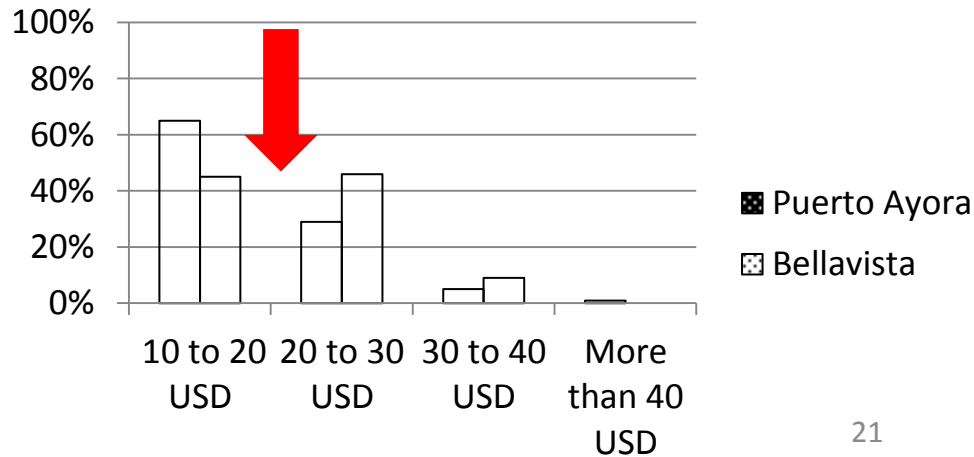
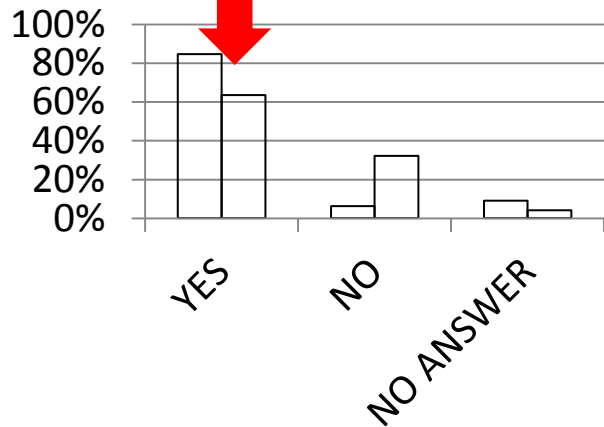
Financial deficit for Puerto Ayora and Bellavista

Settlement	Cost of supplied water* (USD/year)	Total billed (USD/year)	Total collected (USD/year)	Deficit with total billed (USD/year)	Deficit with total collected (USD/year)
Puerto Ayora	993,384	211,538	190,926	781,846	802,458
Bellavista	114,476	74,744	71,620	39,732	42,856
TOTAL	1,107,860	286,282	257,653	821,578	850,206

*Considering only O&M costs



Analysis on willingness to pay and different tariff structures



Various scenarios on increase of current water tariffs

Settlement	Total Billed for 2013	Scenario 1 (20%)	Scenario 2 (40%)	Scenario 3 (60%)
Puerto Ayora	211.538	380.768	528.844	634.613
Bellavista	74.744	126.797	174.082	207.858
Total	286.282	507.565	702.927	842.470
Deficit 1*	2.892.547	2.671.264	2.475.902	2.336.358
Deficit 2**	821.578	600.295	404.933	265.389

*Includes investment costs** Only operations and management costs

Implementation of different tariff structures

Scenario	Total Revenue (USD/Year)
Linear Tariff Structure	932,045
Increased Block Tariff	1,003,428

Cost of supply:

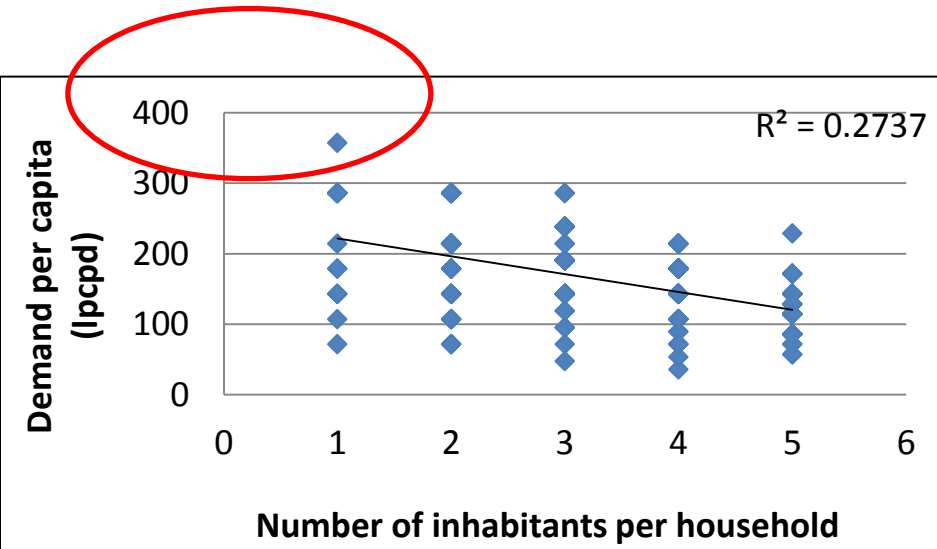
1,107,860

Presentation Structure

- 1) General Information
- 2) Problem Description
- 3) Objective
- 4) Methodology
- 5) Results
 - Average costs of water supply in Santa Cruz
 - Analysis on willingness to pay and different tariff structures
 - Scenarios
- 6) Conclusions
- 7) Further Research

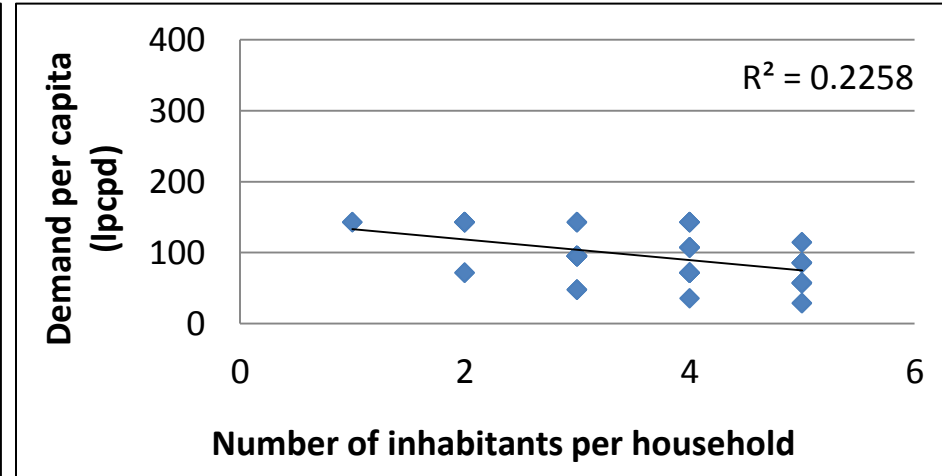
Influence of tariffs in Water Demand

- Puerto Ayora



Fixed Tariff → 5.24 USD/month

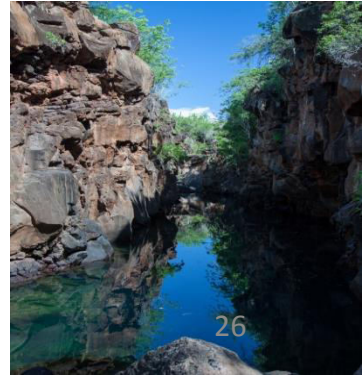
- Bellavista



Consumption-based Tariff → 1.21 USD/m³

Conclusions

- Need for standardized penalties (no payment and spilling tanks)
- High investment is needed if desalination (viable option is installed)
- Installation of water meters to reduce demand (Puerto Ayora)
- Investments could be partly covered by tourists (hotels' rates)



IMPLICATIONS OF WATER TARIFF STRUCTURE ON WATER DEMAND IN SANTA CRUZ ISLAND (GALÁPAGOS)

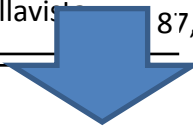
By: Maria Reyes, MSc.

m.reyesperez@unesco-ihe.org

Non-Revenue Water

Settlement	Settlement Demand (lpcpd)	Settlement Total Demand (m ³ /year)	Total Supply (m ³ /year)	NRW (m ³ /year)
Puerto Ayora	163	712,188	1,103,760	391,820
Bellavista	96	87,600	94,608	7,008

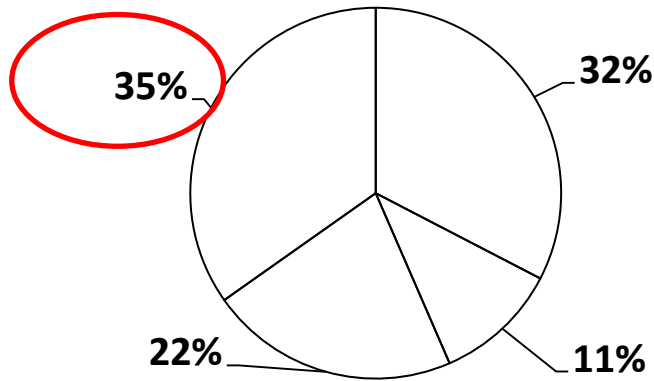
Bellavista



Scenario	Demand (lpcpd)	NRW
Surveys	96	7%
Municipal Cadastre (1)	56	46%
Municipal Cadastre (2)	87	16%

Average payment per month for bottled water

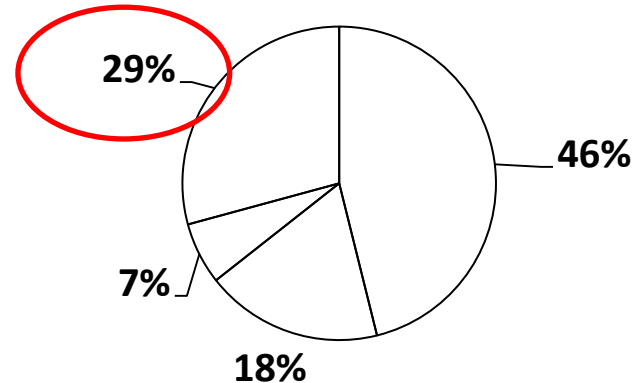
- ☐ 5 to USD 10
- ▣ 11 to USD 15
- ▤ 16 to USD 20
- ▥ Above 20 USD



Bellavista →

← Puerto Ayora

- ▣ 5 to 10 USD
- ▤ 11 to 15 USD
- ▥ 16 to 20 USD
- ▦ Above 20 USD

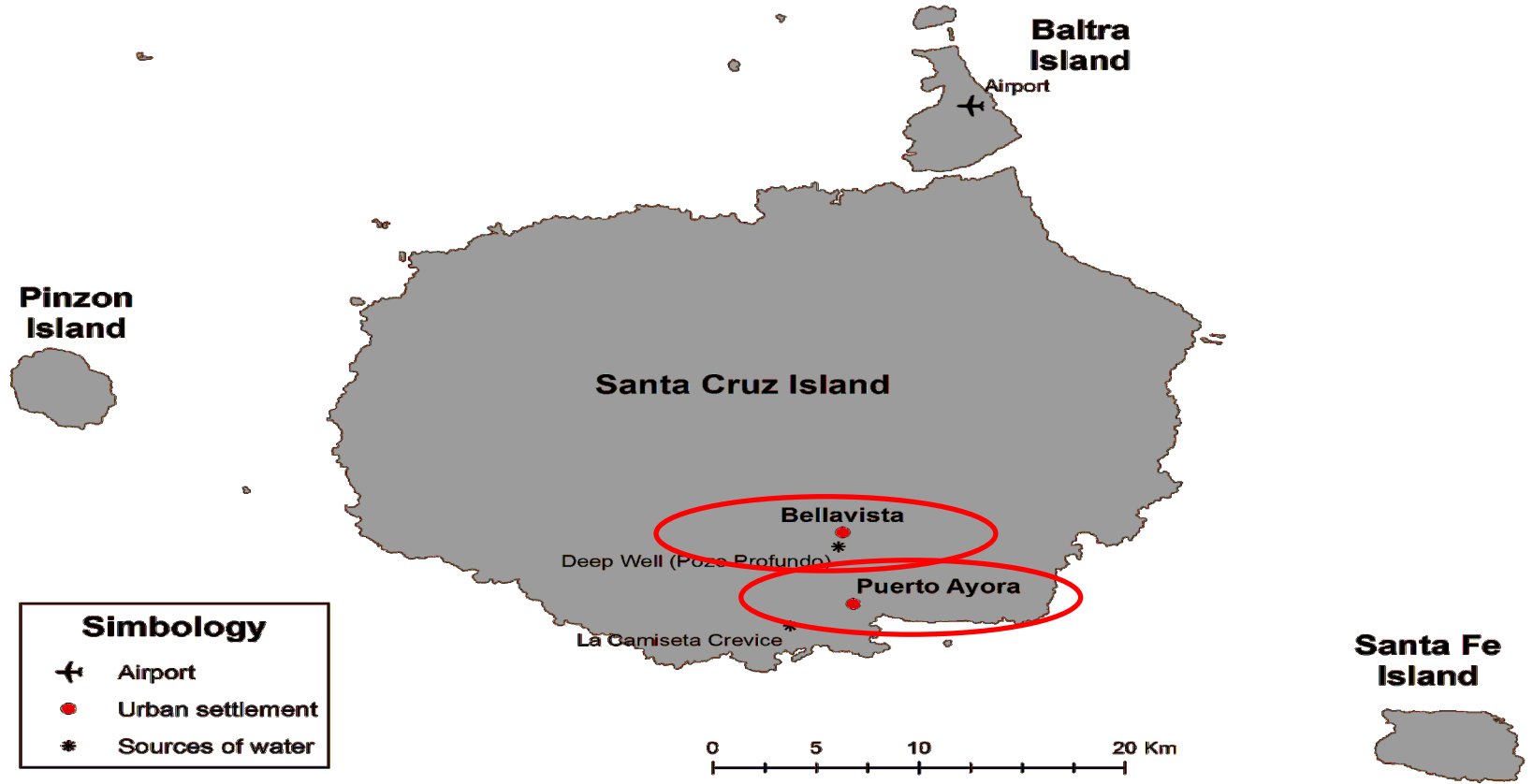


Fast increment of tourist facilities

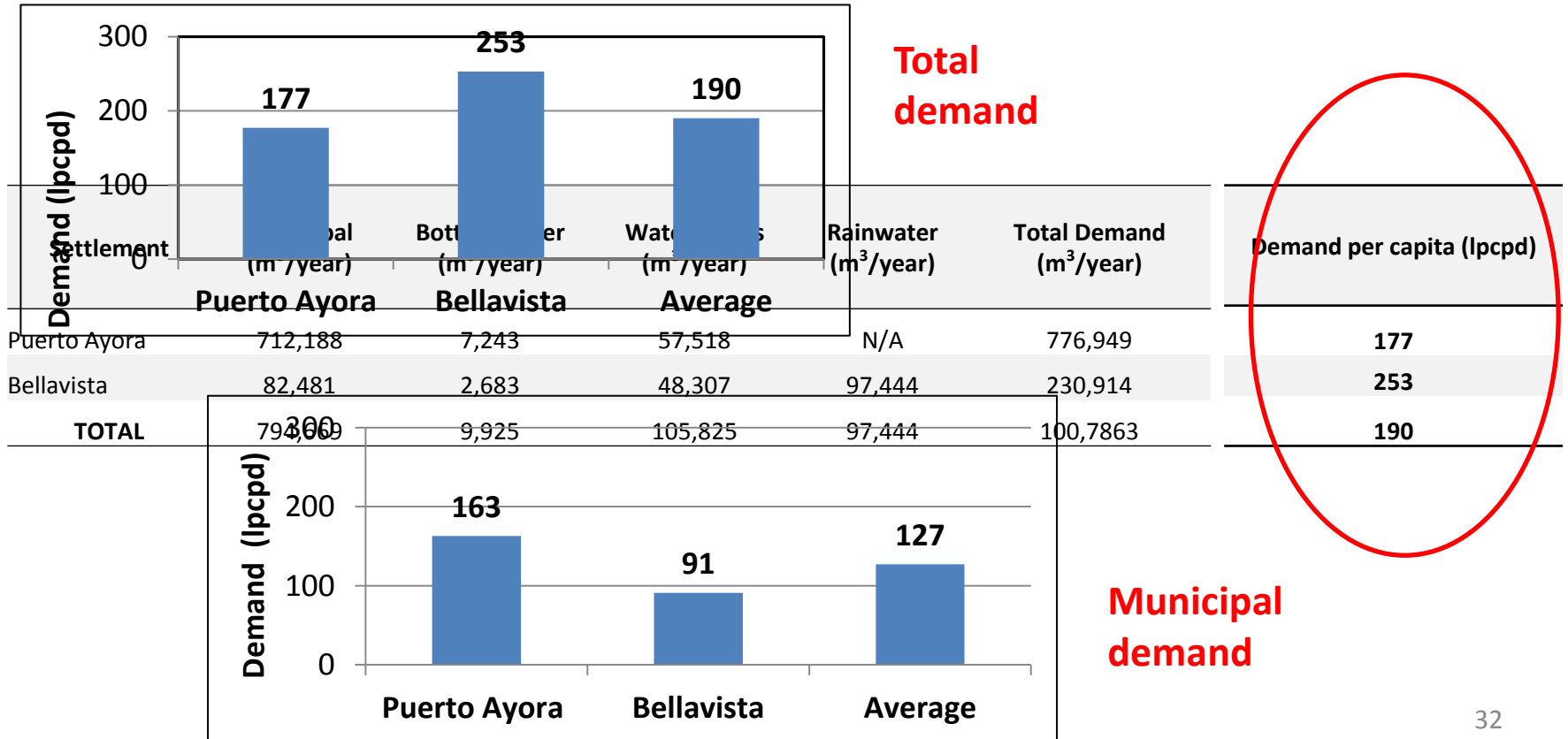
- *hotels, restaurants, bars, and others*
- Higher water demand
- Pressure on scarce water resources



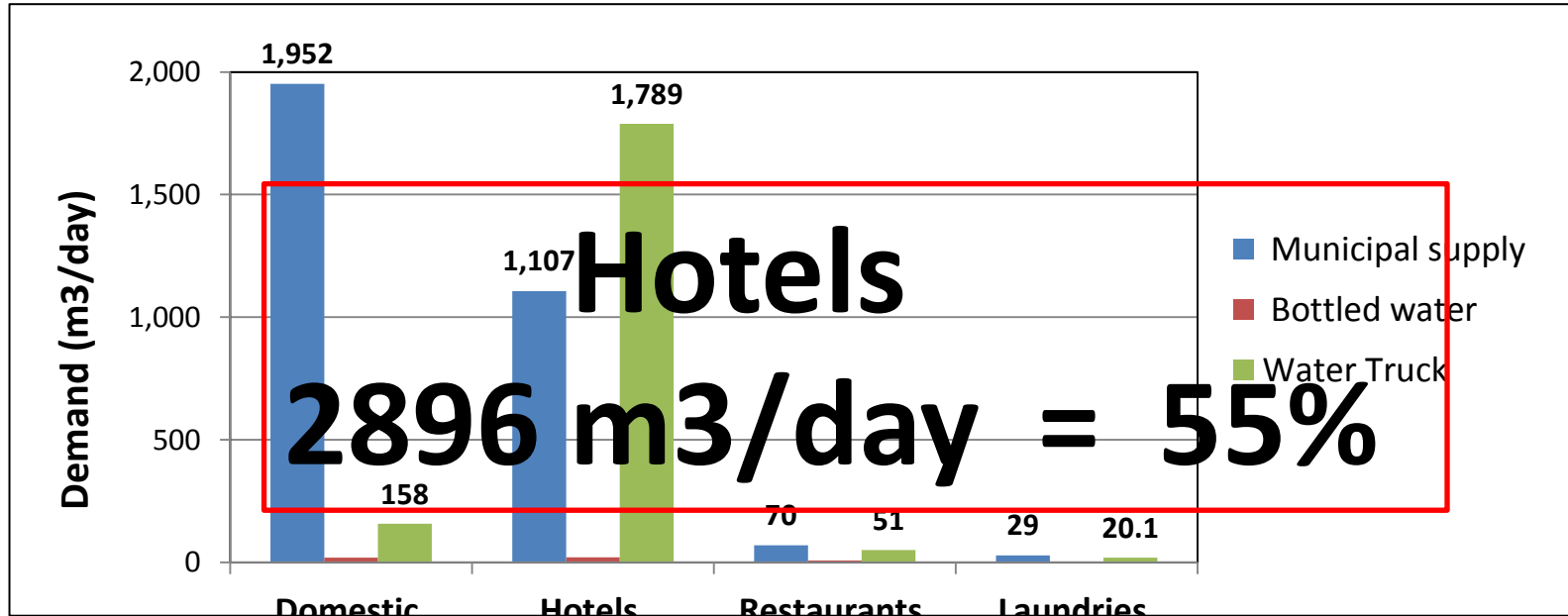
Puerto Ayora



Quantification of total domestic water demand



Total demand quantification (all categories)



Further Research

- Water Balance of Sta. Cruz
- Water Demand Forecasting
- EIA



Other Problems

- **4) Lack of communication and proper management among institutions**
- **5) Wastewater recollection and disposal /contamination**
- **6) Lack of information**



Overall Objective of PhD Research



To analyse the current water supply situation and demand management practices in Santa Cruz and develop feasible demand management strategies for the future

Development of a decision support tool to optimize water resources contributing to better quality of life in the islands.

Approach of PhD Research

WATER SUPPLY ASSESSMENT

- municipal (Losses)
- rainwater
- Bottled (DES)
- water trucks



WATER DEMAND QUANTIFICATION

- domestic
- touristic
- commercial



WATER DEMAND FORECASTING

- micro-components
- pop. growth
- climatic variability (uncertainties)



WASTE WATER TREATMENT-REU

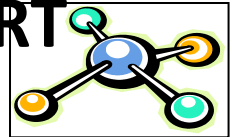
Types of treatment



DECISION

SUPPORT

TOOL



COSTS

- supplied water
- bottled water
- wastewater treatment
- desalination
- drinking treatment

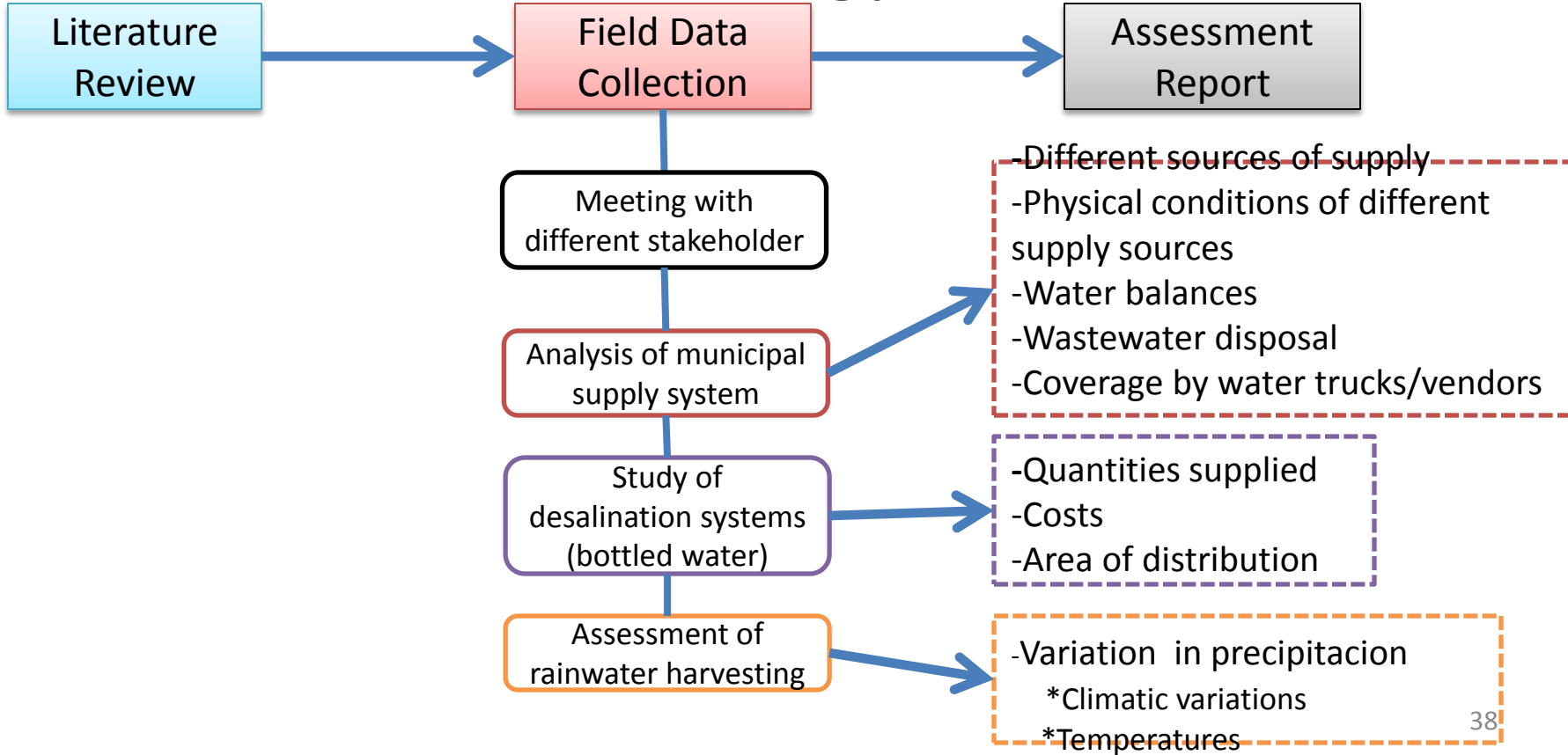


-Optimal solutions for the next 25 years (balance/equilibrium between demand and supply)

-Possible scenarios with alternatives for the next 5, 10, 15, 20 and 25 years

STAGE ONE

Methodology



Preliminary results of first stage

- Municipal supply system → two independent networks between Puerto Ayora and Bellavista

Characteristic	Puerto Ayora	Bellavista
No. of connections	2591	435
Type of Tariff	Fixed	Metered
Extraction site	Crevice "La Camiseta"	Constructed Deep Well
Type of Water	Brackish	Brackish
Previous treatment	NO	NO
Constant Supply	NO	NO
Management	Department of Potable Water	Department of Potable Water

Comparison between two systems

Category	Number of connections	Fixed Value (USD/month)
Metered (Bellavista)*	444	1.21/m ³
Domestic	1152	5.24
Commercial	936	11.24
Small Hotels	14	28.5
Industrial/ Laundries	7	45
Big Hotels	20	45.00
Official	28	6.12
Pool	1	28.50
TOTAL	2602	--

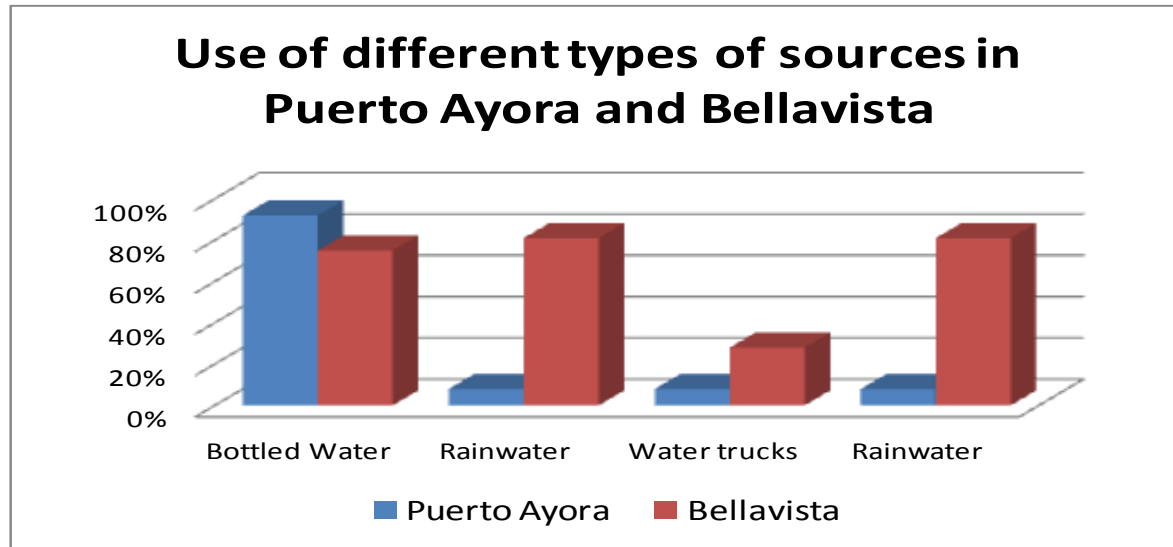


Different Tariff Structures



Preliminary results for Stage 2

- Locals have had the need to look for alternative sources of water



Problem Description

4) Lack of communication and proper management among institutions

According to MINTUR → 159 tourist accommodations (only 53 legally registered)

According to Municipality of SC → 118 accommodations

According to Department of Potable Water and Sanitation (DPWS) → 32 touristic connections

WATER BALANCE FOR

PUERTO AYORA

W_1 - Municipal Water:
3040 m³/day

W_2 -Bottled Water:
25 m³ each/day =
**150 m³/day * (82.7%) =
123 m³/day**

W_3 - Direct 'private'
pumping:
1304 m³/day



D_n = Domestic demand
 R_n = Restaurant demand
 H_n = Hotels demand
 L_n = Laundries demand

$$C_1 = D_1 + R_1 + H_1 + L_1$$

$$C_1 = 1951 \text{ m}^3 + 69 \text{ m}^3 + 1107 \text{ m}^3 + 29 \text{ m}^3 = \mathbf{3156 \text{ m}^3}$$

$$C_2 = D_2 + R_2 + H_2$$

$$C_2 = 19.8 \text{ m}^3 + 7.6 \text{ m}^3 + 20.6 \text{ m}^3 = \mathbf{48 \text{ m}^3/\text{day}}$$

$$C_3 = D_3 + R_3 + H_3 + L_3$$

$$C_3 = 157 \text{ m}^3 + 51 \text{ m}^3 + 1789 \text{ m}^3 + 20 \text{ m}^3 = \mathbf{2017 \text{ m}^3}$$

WATER BALANCE FOR BELLAVISTA

W₁- Municipal Water Supply System:
-Deep Well=**259 m³/day**

W₂-Bottled Water (6 desalination companies):
25 m³ each/day =
150 m³/day
***(17.2%)= 26 m³/day**

W₃- Rainwater Harvesting*:
247 m³ /day

*based on total roof area and average precipitation for 2011 and 2012.



C₁ -226 m³/day
C₂ -7 m³/day
C₃ - 267 m³/day

TOTAL DEMAND= 500 m³/day
***excluding water trucks**

Problem Description

- **5) Wastewater recollection and disposal – contamination**
- No wastewater treatment
- Precarious and anti-hygienic septic tanks
- Collapsing
- Contamination of



Problem Description

6) Lack of information

- Lack of information regarding water supply and demand.
- Considerable gaps in water demand assessments and data in most books of records.



Water Demand Quantification

- Survey research method in fieldwork period from September 2013 to January 2014.

Type of property	No. of properties	Percentage from the universe	Optimal number of surveys*	Real number of surveys made
Domestic	1996	68.9	233.7	240
Hotels	159	5.5	18.6	29
Food and Beverages	49	1.7	5.7	30
Laundries	5	0.2	0.6	16
Bellavista	435	15.0	50.9	59
Others (excluded)	251	-	-	-
Total (Universe)	2895	91	310	374

Main parts contained in the survey (Domestic-PA and Bellavista)

- (i) General information → location and description of the household
- (ii) Demand patterns → schedules and habits,
- (iii) Water demand → bottled, municipal, rainwater and from trucks
- (iv) Tariffs and willingness to pay
- (v) Environmental awareness → saving of water and negligences
- (vi) Wastewater treatment

Survey for hotels, restaurants and laundries

- (i) General information
- (ii) Average capacity of customers
- (iii) Water demand quantification regarding different type of sources
- (iv) Willingness to pay
- (v) Environmental awareness



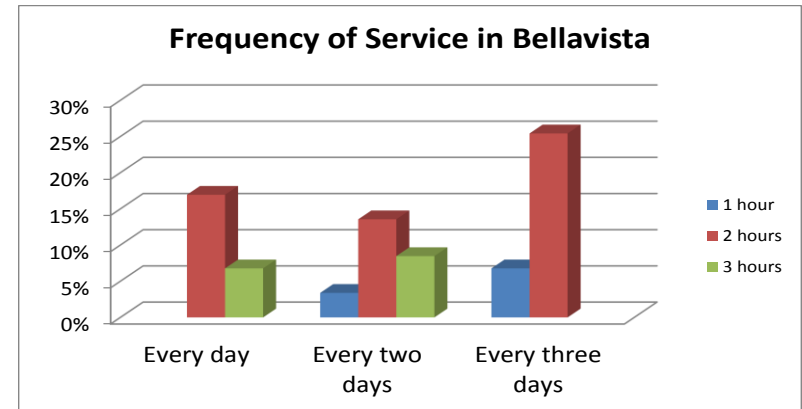
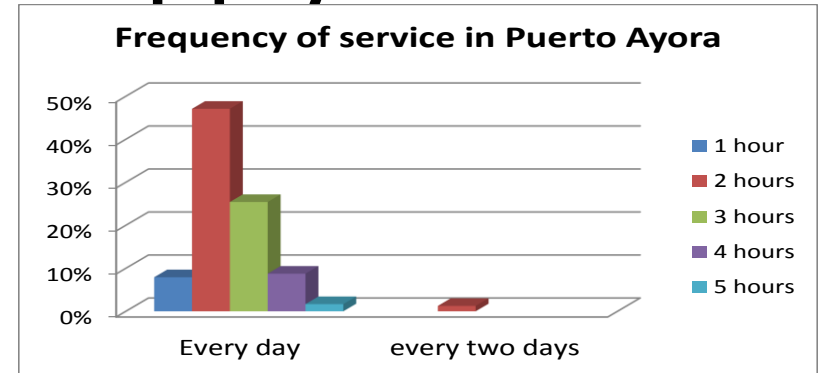
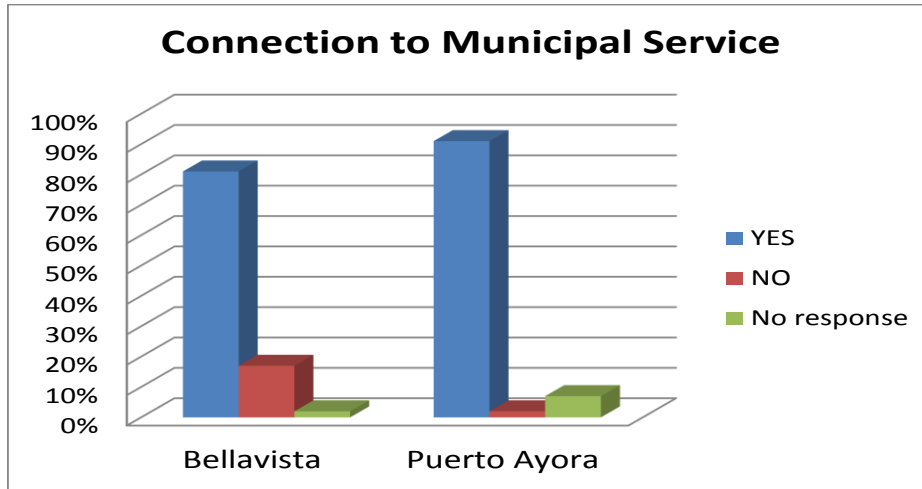
Results

Name	Pumping Flow (l/s)	Pump Power (HP)	Average pumping (h)	Approximate Leakage*	Extraction (m3/d)	Volume (m3/year)	Water treatment
La Camiseta (Puerto Ayora)	35 (2 pumps)	50	12	25%	3024	1103760	NO
Deep Well (Bella Vista)	6	25	12	15%	259.2	94608	NO

'Private' pumping

Private extraction sources			
Name of crevice	Estimated Extraction (m3/d)	Volume (m3/year)	Water treatment
Ingala (1 municipal pump)	648	236520	NO
Ingala (other private pumps)	296	108040	NO
Fundacion Charles Darwin	701	255865	NO
Ninfa	4	1460	NO
Cascada	192	70080	NO
Misión Franciscana	25	9125	YES
Gallardo	25	9125	YES
Tortuga Bay (3)	60.5	22082.5	SOME
TOTAL	1951.5	712297.5	

Municipal Supply



Storage for municipal water

- Due to unreliability of service locals need storage for municipal water

