# Water balances for MUS in Colombia

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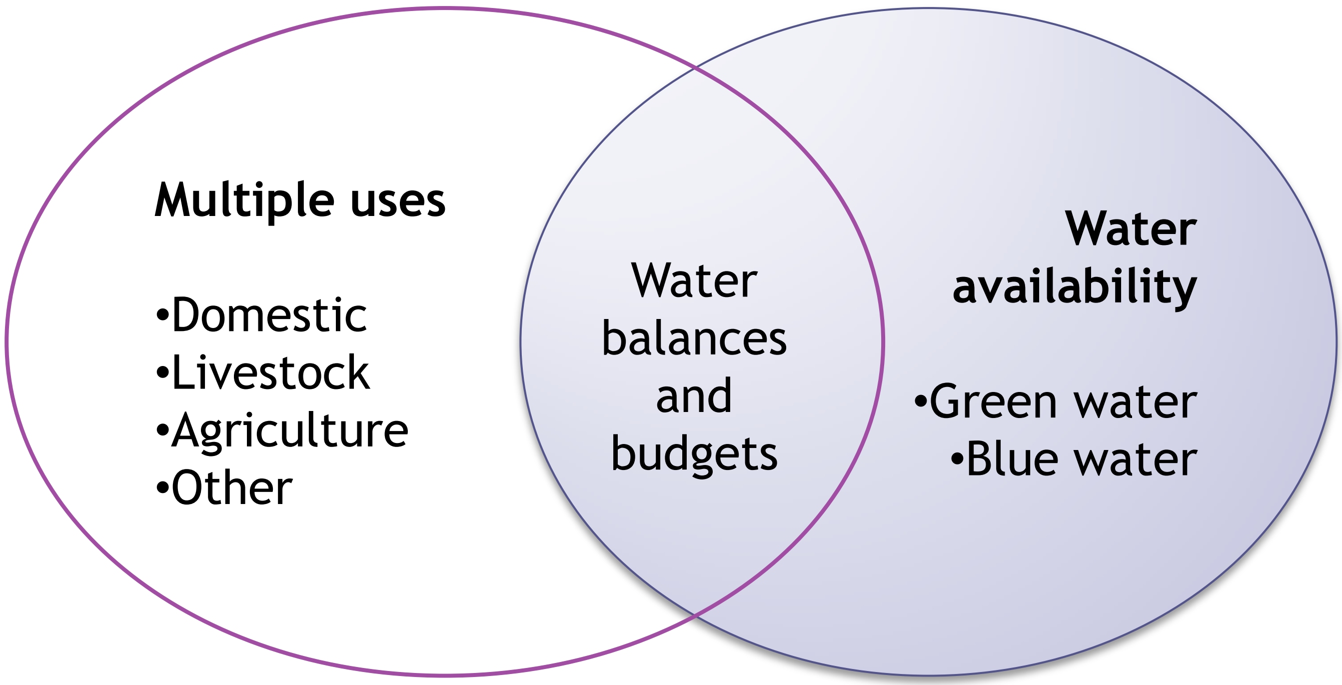
# Background

- MSc project supervised by Mr. Ian Smout from WEDC, Loughborough University
- Previous studies on MUS in the case study area
- Intended contributions to the knowledge in the topic:
  - Necessity to combine qualitative and quantitative methods to understand demands for MUS, integrating knowledge and tools from different disciplines
  - Increase the knowledge on the supply side on MUS, introducing the green water branch to the process of planning for the blue water branch
  - Address equity issues: how different users benefit from the possibility to use the water for productive activities within the system

# Conceptual framework

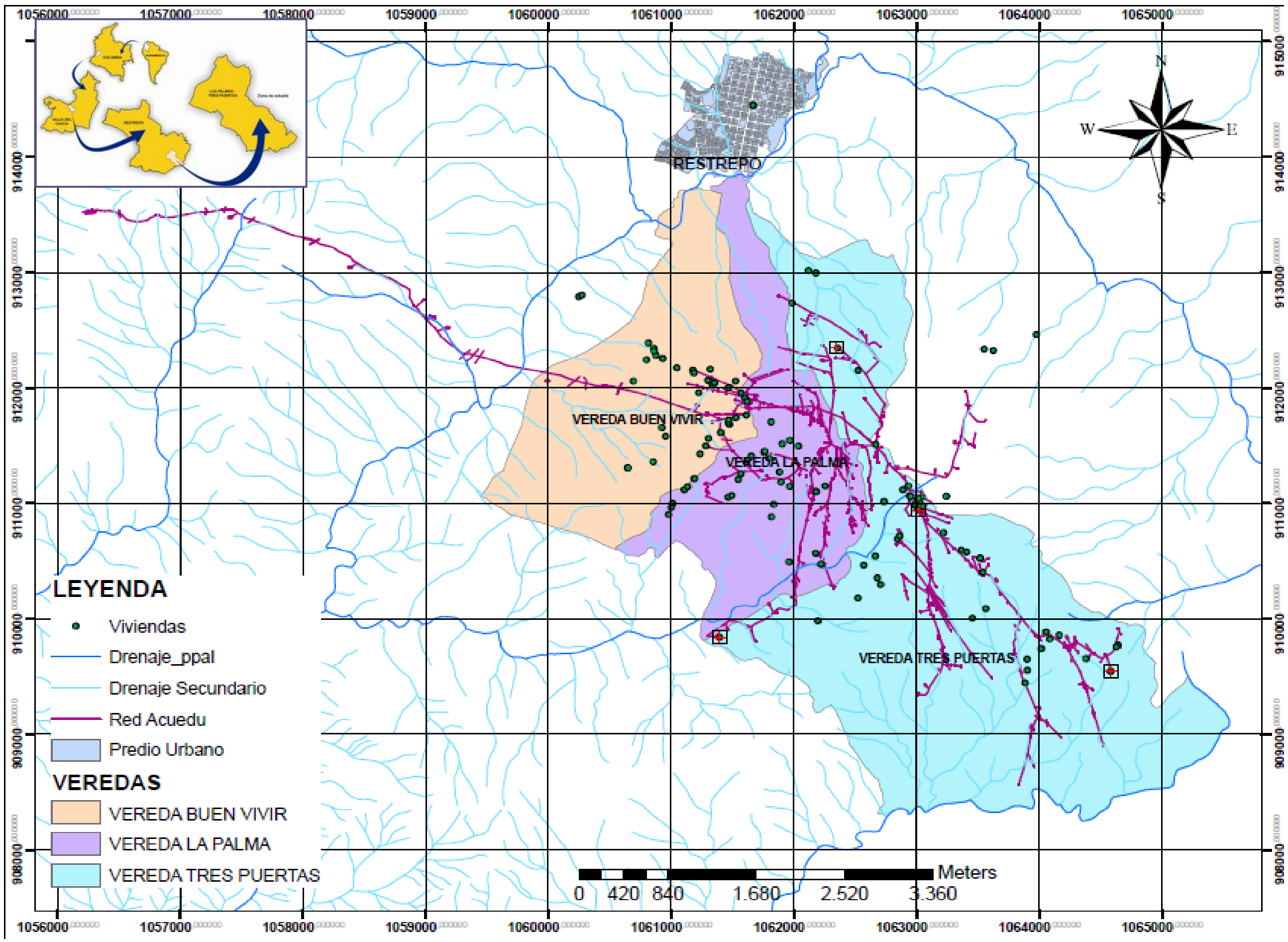
**Planning of rural water supply systems for MUS in rural areas**




Poverty alleviation
Sustainable livelihoods approach
Demand responsive approach
Sustainability

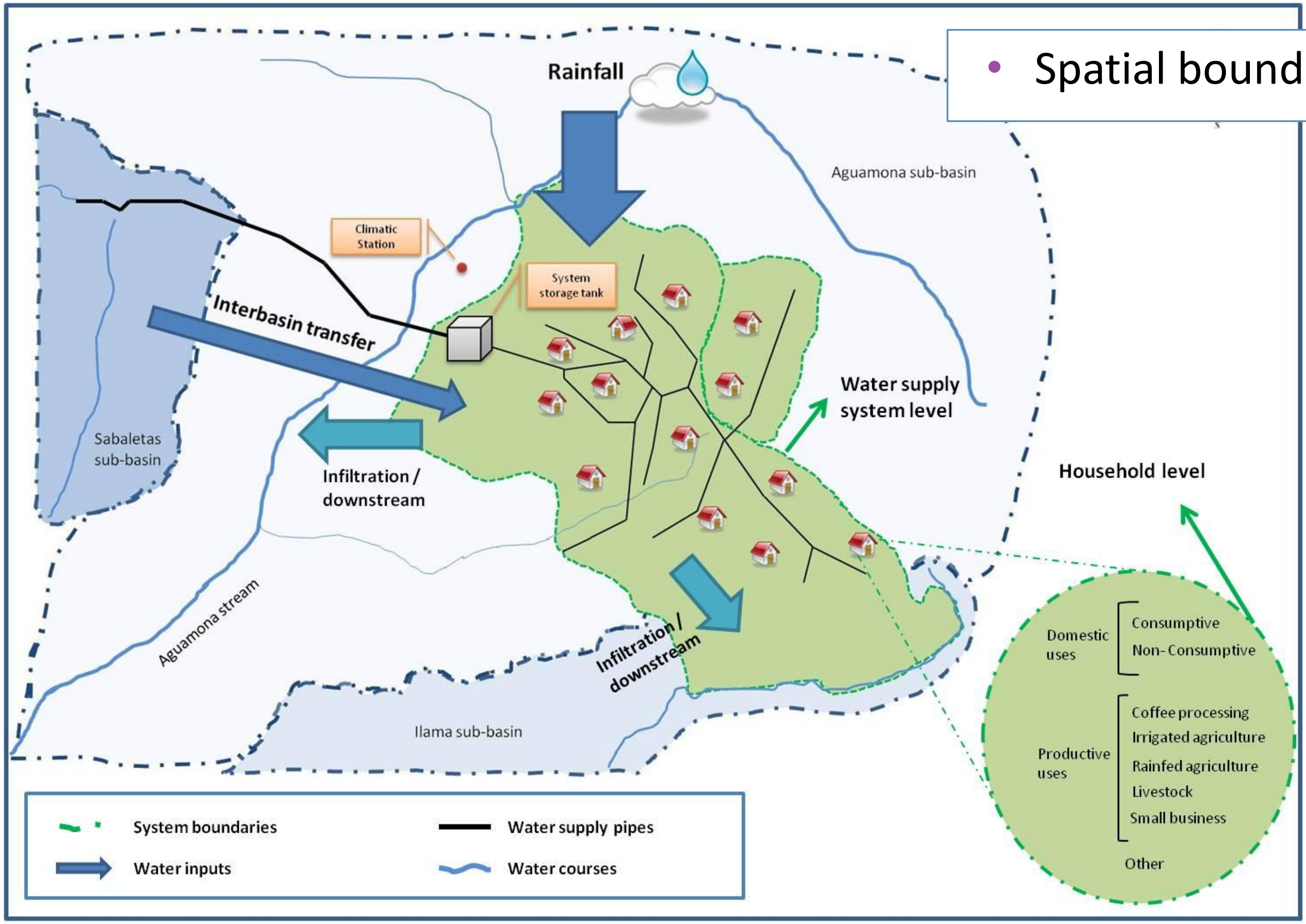
# Water balances for MUS: La Palma Tres Puertas case study

# The case study area




- Households: 437
- Main livelihoods : agriculture and animal husbandry
- Water service coverage: 100%
- Intermittent service
- Storage tanks at household level
- Water committee in charge of management
- Differentiated water tariff according to consumption

# System boundaries, inflows and outflows

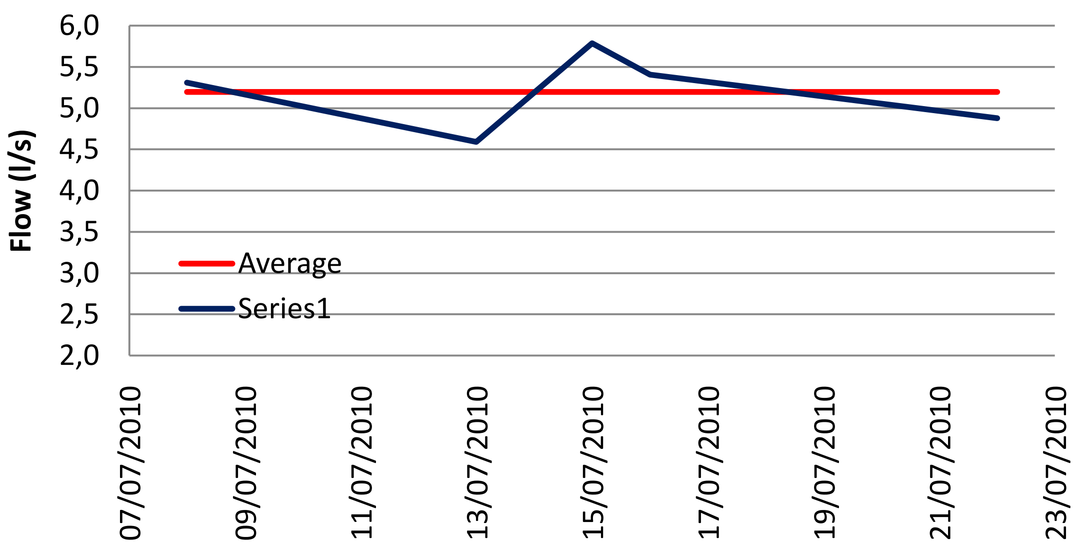



- Spatial boundaries

- Temporal boundaries: June – July 2010

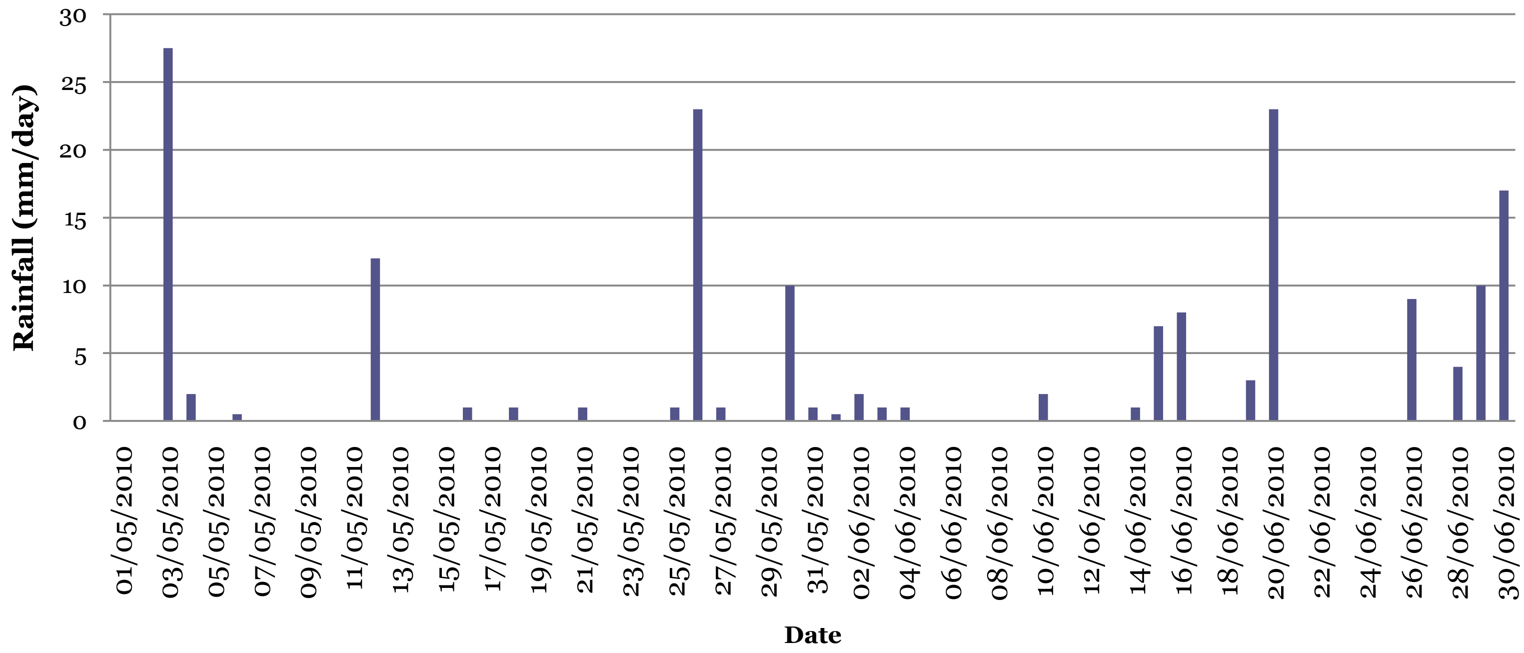
# Water availability - inflows (I)

- Water supply
  - Measurement of the water entering to the centralized storage tank of the water supply system
  - Five days during the analysis period
  - Volume supplied was calculated as the average of the data taken



# Water availability - inflows (II)

- Rainfall
  - Obtained from records of *a* Climate Station located in the area
  - Total rainfall during the period was 169,5 mm



# Water demand - outflows (I)

**Two sources of information**

- **Household survey to collect information significant for a "disaggregated" demand estimation**
  - Household size
  - Total area of the household
  - Cropped area by type of main crops
  - Number of animals per species
- **Records from household meters**

# Balance adjustment

## Blue water branch

**THC = DC + LC + CPC + SBC + CBWC + other**

Where:

THC = Total Household Consumption provided from meters records

DC = Domestic Consumption

LC = Livestock Consumption

CPC = Coffee Processing Consumption

SBC = Small Business Consumption

CBWC = Crop Blue Water Consumption

## Green water branch

**P = CGWC + DW + GW**

Where:

P = Precipitation

CGWC = Crop green water consumption (irrigated + rainfed)

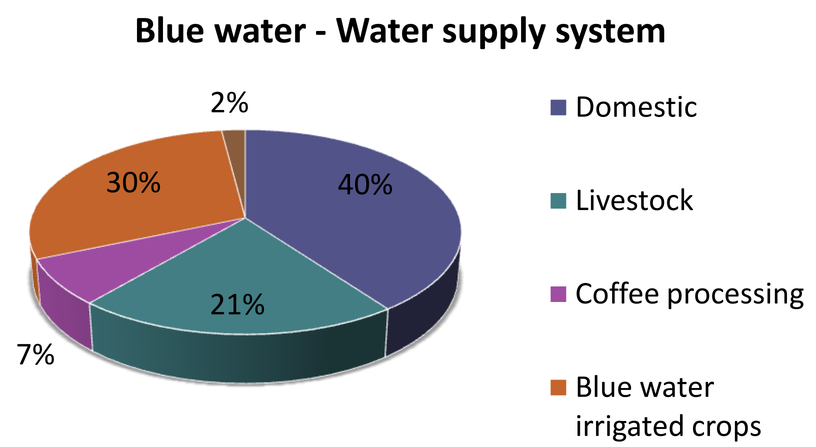
DW = Downstream

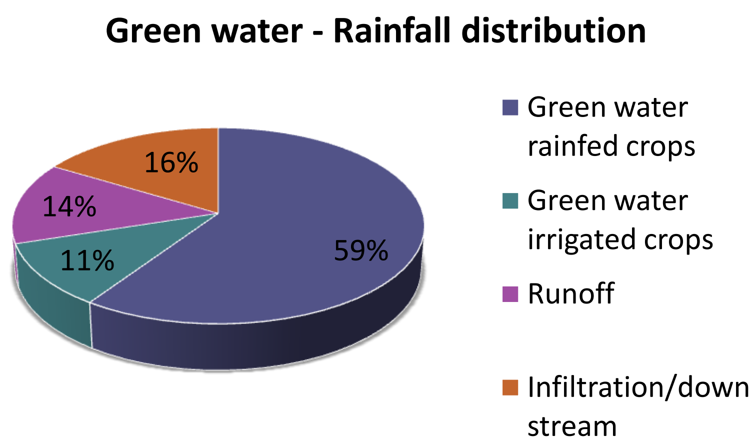
GW = Groundwater

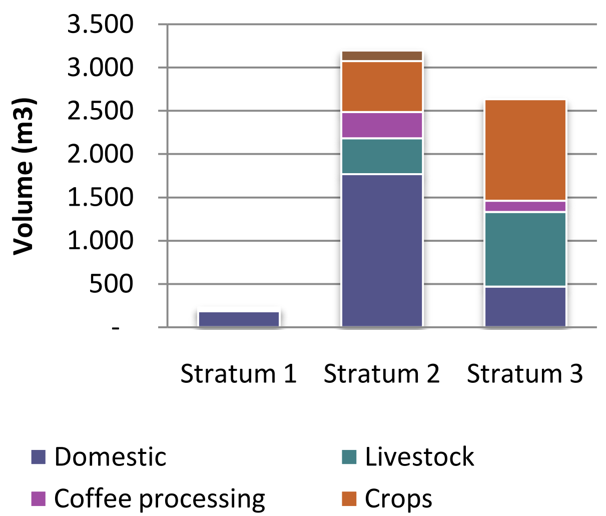
# Water demand - example of some outflows estimation

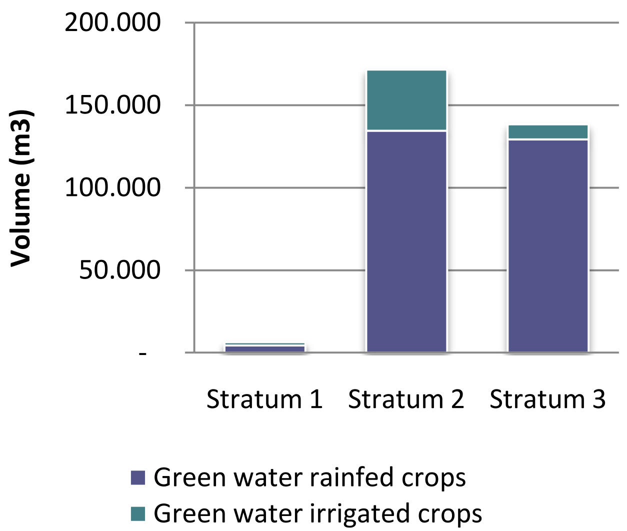
| Water Use | Formula | Variable | Factor |
|---|---|---|---|
| Domestic consumption (DC) | $DC = Household\ size \times Domestic\ percapita\ \ consumption \times \frac{60}{1000}$ | Household size | |
| | | Domestic per capita consumption (lpcd) | |
| Livestock consumption (LC) | $LC = \left(\sum_{i=7} Number\ of\ animals\ especie_i * Water\ consumption\ factor\ especie_i \times \frac{60}{1000}\right.$ | Number of cows | 40 l/head*day |
| | | Number of chickens | 0,15 l/head*day |
| | | Number of pigs | 20 l/head*day |
| | | Number of horses | 20 l/head*day |
| Coffee processing consumption (CPC) | $CP = Productivity\ factor \times Water\ consumption\ system\ factor \times Cropped\ area\ \times \frac{60}{1000}$ | Water consumption system factor | 0,0042 $m^3$/KgPC |
| | | Productivity factor | 0,035 KgPC/$m^2$ |
| | | Cropped area ($m^2$) | |
| Crop green water consumption (CGWC) | $CGWC = \sum_{i=14} Area\ crop_i \times\ Green\ water\ consumption\ factor\ c$ | Cropped area with coffee | 0,1465 m/period |
| | | Cropped area pineapple | 0,0465 m/period |
| | | Cropped area beans | 0,0705 m/period |
| | | Cropped area maize | 0,1465 m/period |
| | | Cropped area vegetables | 0,1465 m/period |
| | | Cropped area *pitaya* | 0,0837 m/period |
| | | Cropped area *lulo* | 0,1465 m/period |

# Results at the system level



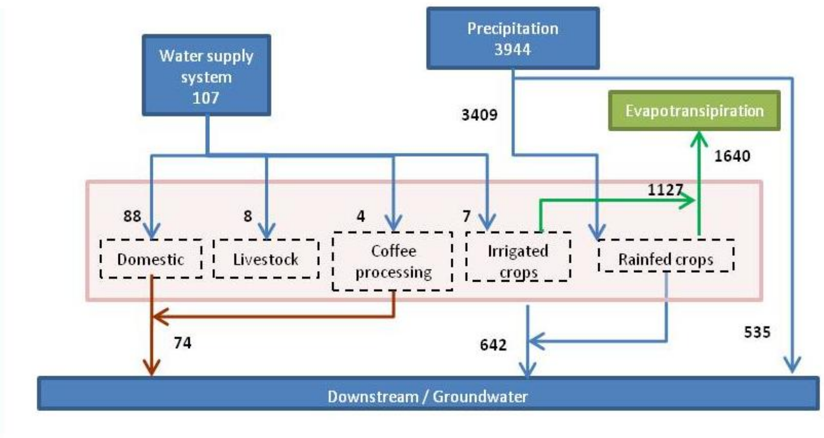



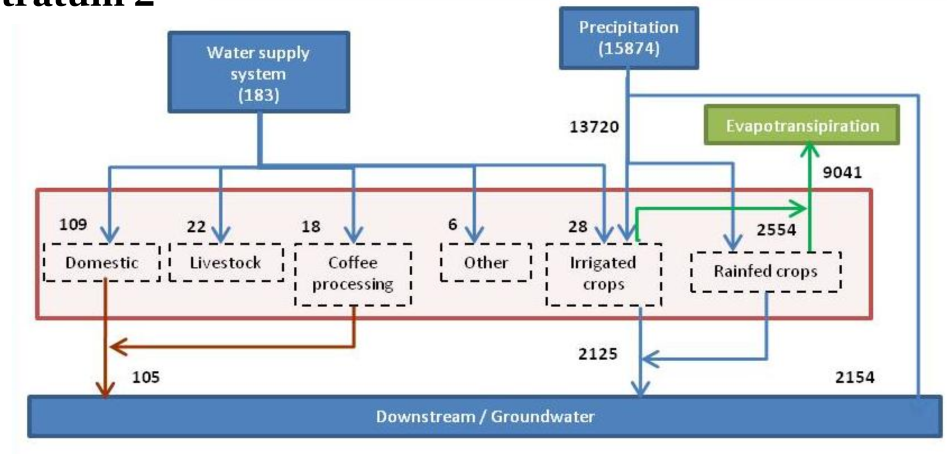



# Results at the household level

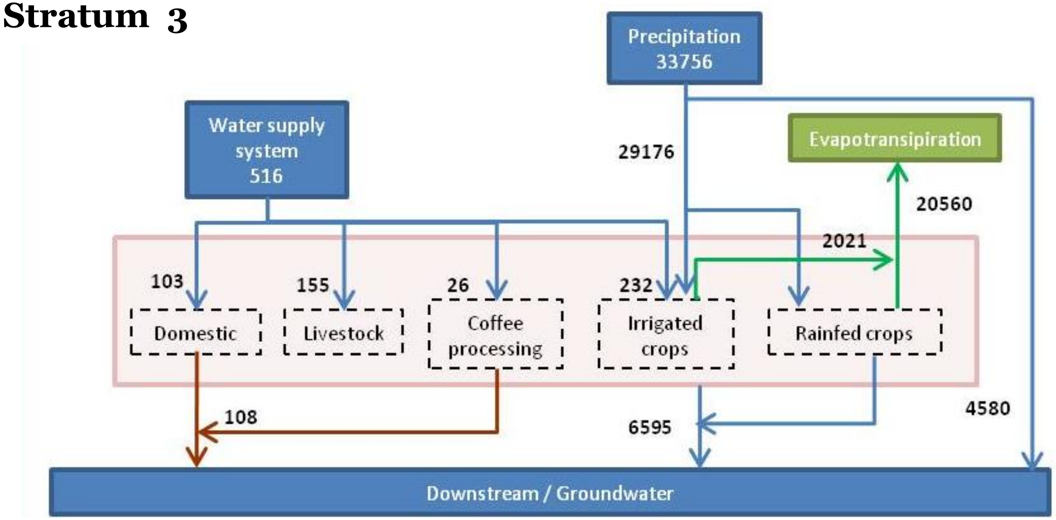
**Stratum 1**




**Stratum 2**




**Stratum 3**




- Per capita domestic consumption varied from 88 to 109 lpcd
- Per capita consumption for productive purposes varied from 19 lpcd to 413 lpcd

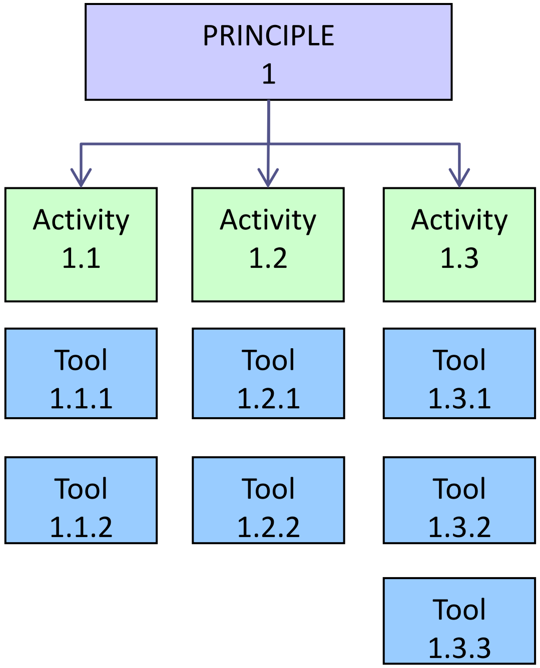
# Conclusions

- Water balance concepts and budgets  probed to be flexible tools to:
  - Understand the dynamics of the hydrological cycle and the human cycle in a MUS system
  - Suit the objectives of a study, scale, and availability of information
  - The stratified analysis allowed estimating water consumption for domestic and productive uses, making clear differences between categories of subscribers within the system

# Other initiatives - MUS guidelines

- Book “Guidelines to design and manage of multiple uses of water supply systems for rural areas in Colombia” by Inés Restrepo, Isabel Domínguez, Silvia Corrales and Sandra Bastidas published by Universidad del Valle in 2010.

- Structure of the guidelines




Concrete principles, activities and tools to address during planning and management for MUS:

•Equity and poverty reduction
•Multiple uses
•Multiple sources
•Sustainable use of water
•Technological alternatives
•Cost recovery
•Tariffs and management rules

# Thank you !!!

Project report available at MUS website: http://www.musgroup.net/

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