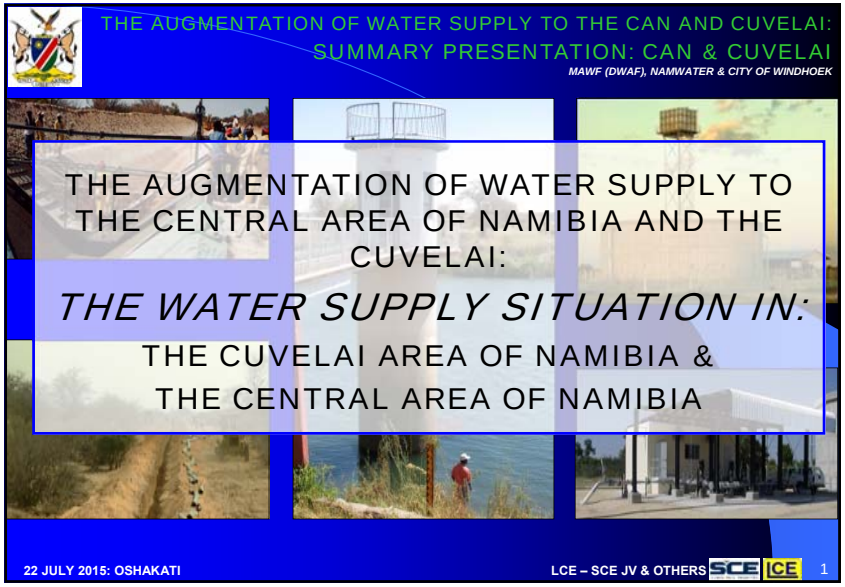


THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

PRESENTATION

1. **PROJECT BACKGROUND**
2. **THE CENTRAL AREA**
3. **THE CUVELAI AREA**

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

1. PROJECT BACKGROUND
1.1 PROJECT PRINCIPLES

- Separate consultancy teams:
  - Engineering Component
  - Environmental & Social Component
- Client liaison via the Project Steering Committee
- Long-term planning: Planning horizon: up to 2050
- 1st Part of the Project: Desk study, pre-feasibility investigation
- 3 Phases to the Project:
  - 1st Phase: Assessment of the water demands and water resources
  - 2nd Phase: Yield assessments, concept schemes, public participation
  - 3rd Phase: Evaluation of schemes, public participation

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

1. PROJECT BACKGROUND
1.2 PROJECT OBJECTIVE

- Project objective:

"To examine all nominally feasible options for securing the long term… water supply to the Central Area of Namibia and the Cuvelai area of Namibia where existing sources might become inadequate in the near future"

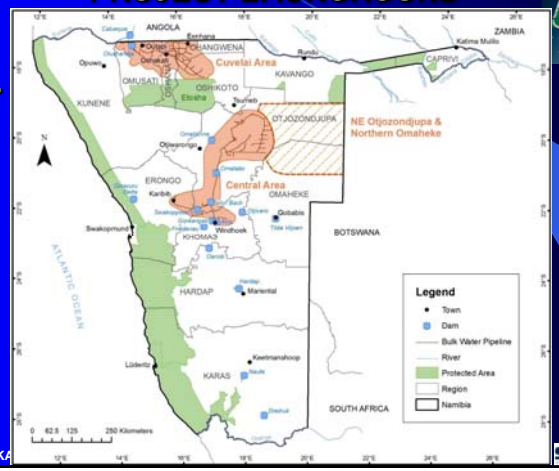
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

1. PROJECT BACKGROUND
1.3 PROJECT TEAMS

- Engineering Consultancy Team:
  - Lund Consulting Engineers CC & Seelenbinder Consulting Engineers CC (JV)
  - Environmental Engineering Services
  - Manfred Redecker Consulting Engineer
  - Pedro Maritz Civil Consultant
  - Professional Environmental Technologies
  - Dynamic Water Resources Management
  - The Maproom
  - AECOM
- Environmental & Social Consultancy Team:
  - Sustainable Solutions Trust & Others
  - Southern African Institute for Environmental Assessment

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

1. PROJECT BACKGROUND
1.4 PROJECT AREA



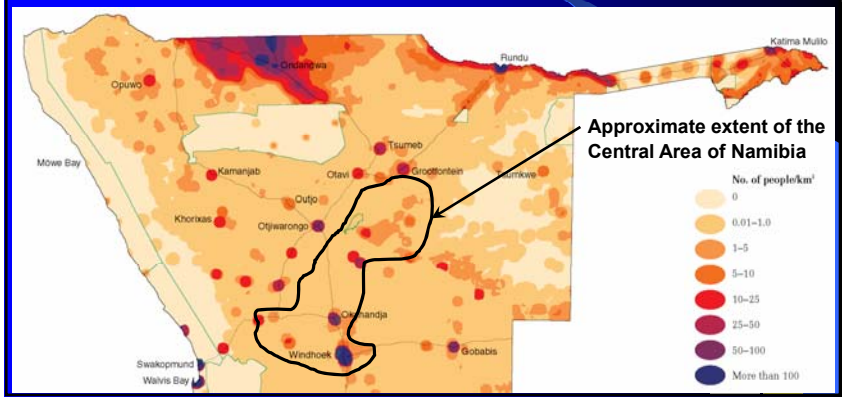
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

2. THE CENTRAL AREA OF NAMIBIA

1. The Central Area of Namibia (CAN)
2. Configuration of infrastructure and water sources in the CAN
3. Overview of population and growth rates, history of water supply, water supply infrastructure, economic importance, water demand projections: Details in Report
4. Water supply sufficiency: available resources and projected water demands
5. Water supply options
6. Water supply and demand modelling
7. Conclusions
8. Considerations and options

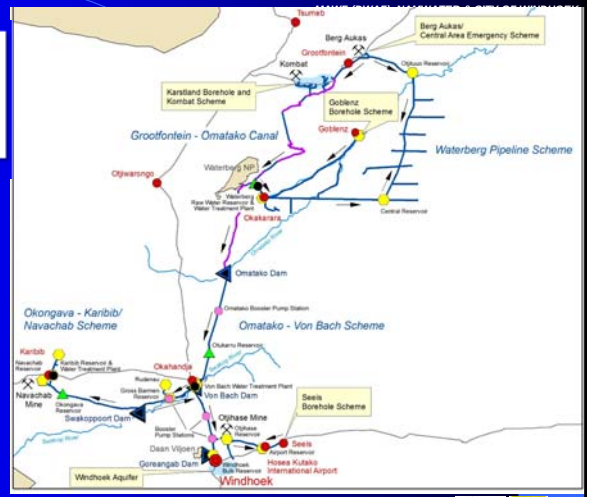
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

2. THE CENTRAL AREA OF NAMIBIA
2.1 THE CENTRAL AREA OF NAMIBIA



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI

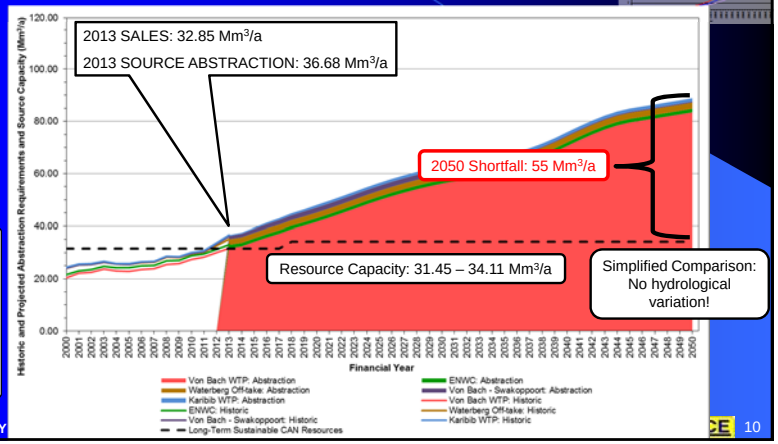
CONFIGURATION OF INFRASTRUCTURE & WATER SOURCES IN THE CENTRAL AREA OF NAMIBIA (CAN)



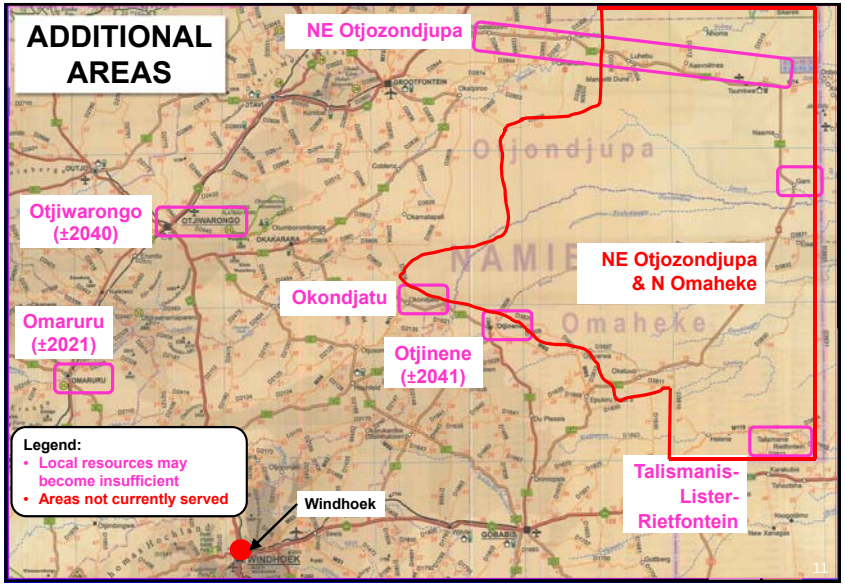
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CAN

2.4.2 Simplified Future Demand Scenario (1)



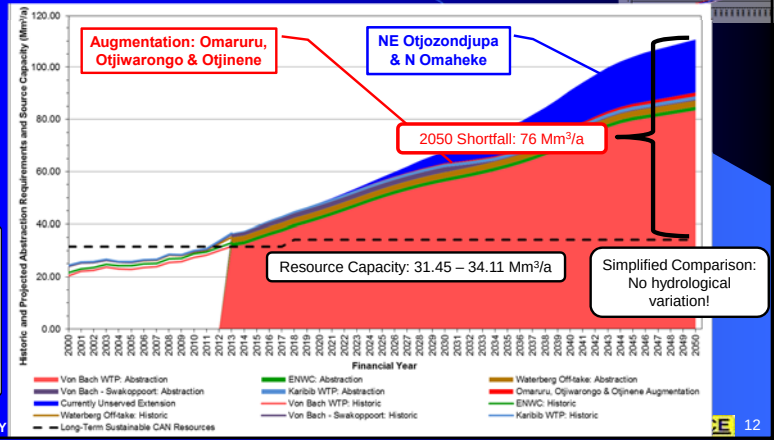
ADDITIONAL AREAS



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CAN

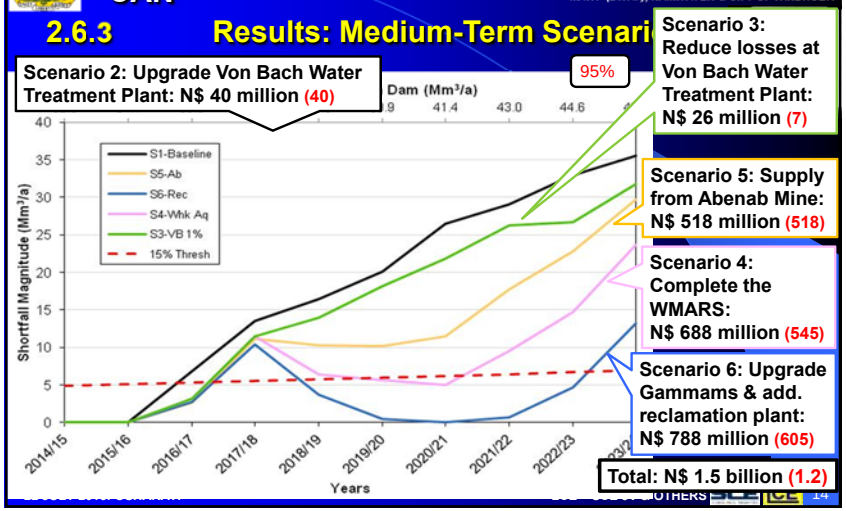
2.4.4 Simplified Future Demand Scenario (2)



2. THE CENTRAL AREA OF NAMIBIA
2.5 WATER SUPPLY OPTIONS

1. Previous assessments:
   - Covering the ENWC, abstraction from the Kunene / Orange Rivers
2. Not considered:
   - Eiseb & Gobabis Aquifers, Zambezi River
3. Aquifers with insufficient information:
   - Tsumeb & Kalahari Aquifers
4. Aquifers with insufficient capacity:
   - Platveld, Otjiwarongo, Omaruru, Osona, Rehoboth, Nauaspoort - Oamites
5. Surface water sources:
   - Friedenau, Oanob & Hardap Dams (insufficient capacity)
6. Okavango River, Desalination

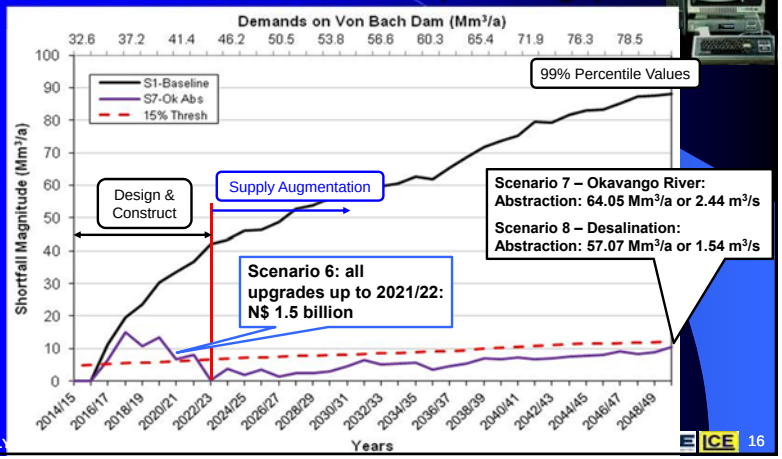
CAN
2.6.3 Results: Medium-Term Scenari



CAN
2.6 SUPPLY / DEMAND MODELLING
2.6.4 Long-Term Supply Options

1. No other water resources large enough within the CAN
2. Only two supply options identified:
   a. Okavango River abstraction
   b. Desalinated sea water from the coast
3. Neither option can be fully implemented in less than 8 – 10 years…?
4. Shortfalls can be expected until full implementation of one of these sources

CAN
2.6.5 Results: Scenario 7 (Okavango)



2. THE CENTRAL AREA OF NAMIBIA
2.7 CONCLUSIONS

- Phase I (assessments of water resources & demands): complete
- Supply / demand modelling has been conducted using the CA-Model
- The CAN faces a major water supply problem:
  - No inflow in 2015/16: Run-dry date: May / June 2016
  - Even with normal rainfall / runoff: Crippling water shortages are to be expected in future
- Medium-Term Strategy:
  - Reducing the shortfalls up to 2022/23: N$ 1.5 billion
- Long-Term Strategy:
  - Plan, Design & Construct long-term augmentation scheme to have water reach the CAN by May 2022

2. THE CENTRAL AREA OF NAMIBIA
2.8 CONSIDERATIONS & OPTIONS

- Environmental and social analyses:
  - Scenario 3: VBWTP supernatant recycling to reduce losses
  - Scenario 4: WMARS expansion
  - Scenario 6: Waste water treatment & advanced reclamation
  - Scenario 7: Okavango abstraction
  - Scenario 8: Desalination…?
- Further considerations:
  - Additional demands of Omaruru, Otjiwarongo & Otjinene?
  - Additional demand in Windhoek (+10% or +21%), NE areas?
- Water demands along possible pipeline routes
- Public participation
- Infrastructure upgrades required
- Costing and other evaluations: Phase 3

3. THE CUVELAI AREA OF NAMIBIA

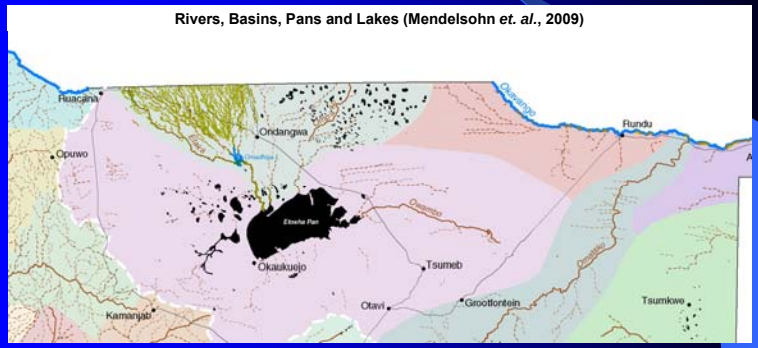
1. The Cuvelai Area of Namibia
2. Overview of water supply in the Cuvelai area
3. Overview of population and growth rates, history of water supply, water supply infrastructure, economic importance: Details in Report
4. Water resources:
   - Surface Water: Kunene River & Surface flow in the *iishana*
   - Groundwater
5. Historic consumption: 2005/06 – 2012/13: 69% of abstraction at Calueque unaccounted for
6. Water demands & supply
7. Summary of current situation
8. Water supply options

3. THE CUVELAI AREA OF NAMIBIA
3.1 THE CUVELAI AREA OF NAMIBIA

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

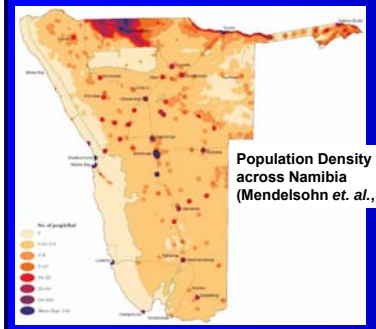
3. THE CUVELAI AREA OF NAMIBIA
3.1 THE CUVELAI AREA OF NAMIBIA

Rivers, Basins, Pans and Lakes (Mendelsohn *et. al.*, 2009)



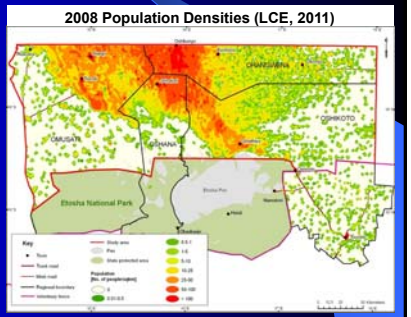
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.1 THE CUVELAI AREA OF NAMIBIA



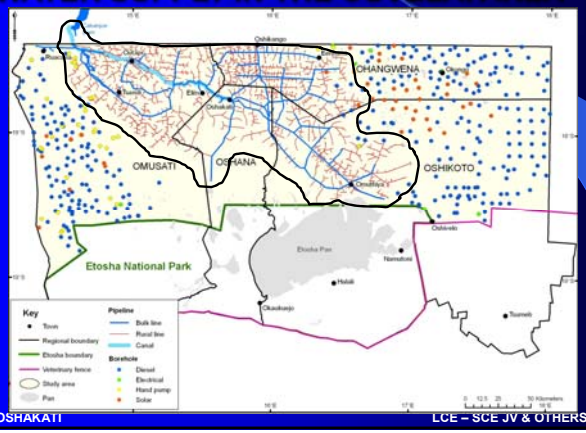
Population Density across Namibia (Mendelsohn *et. al.*, 2009)

2008 Population Densities (LCE, 2011)



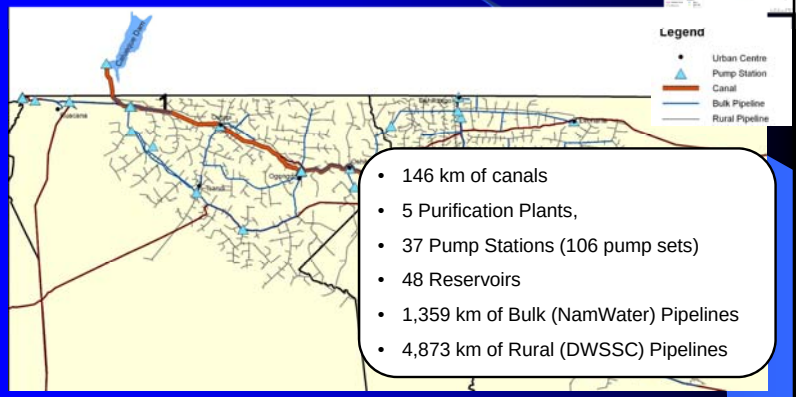
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.2 WATER SUPPLY IN THE CUVELAI AREA



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

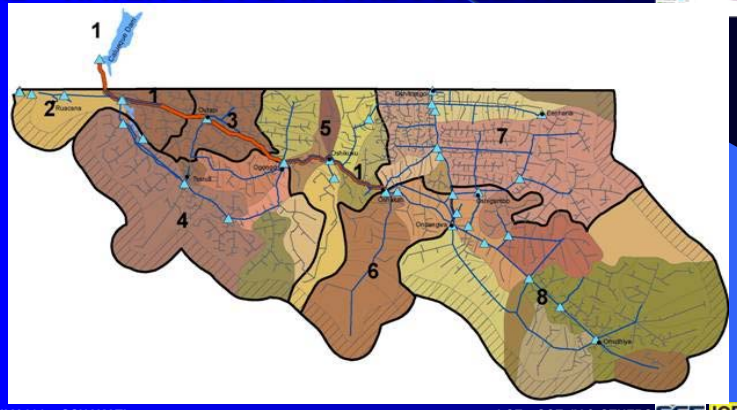
3. THE CUVELAI AREA OF NAMIBIA
3.2 WATER SUPPLY IN THE CUVELAI AREA



- 146 km of canals
- 5 Purification Plants,
- 37 Pump Stations (106 pump sets)
- 48 Reservoirs
- 1,359 km of Bulk (NamWater) Pipelines
- 4,873 km of Rural (DWSSC) Pipelines

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.2 WATER SUPPLY IN THE CUVELAI AREA



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.6 WATER DEMANDS & SUPPLY

Demand scenarios: Low likely, Likely, High Likely
Population growth rates: Different for urban & rural
Water demand norms and losses: Different for urban & rural
Known future developments incorporated
Urban water demands
Rural water demands
Irrigation water demands

Details in the Report

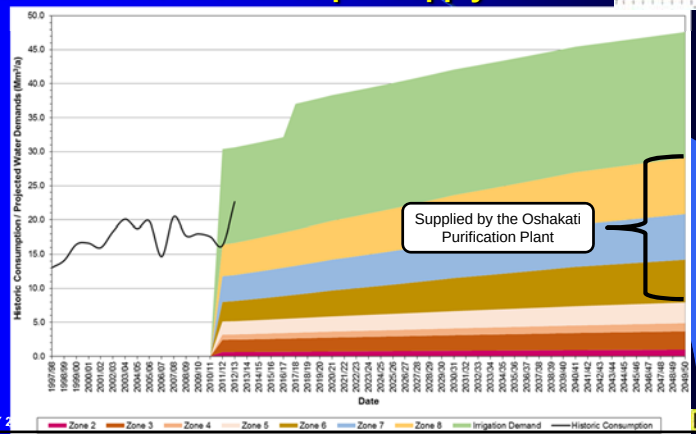
1. Total water demands
2. Water demands per zone
3. Total abstraction requirements at Calueque

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI
3.6 WATER DEMANDS & SUPPLY
3.6.1 Total Water Demands: Urban, Rural & Irrigation

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

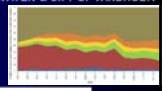
CUVELAI
3.6 WATER DEMANDS & SUPPLY
3.6.2 Water Demands per Supply Zone



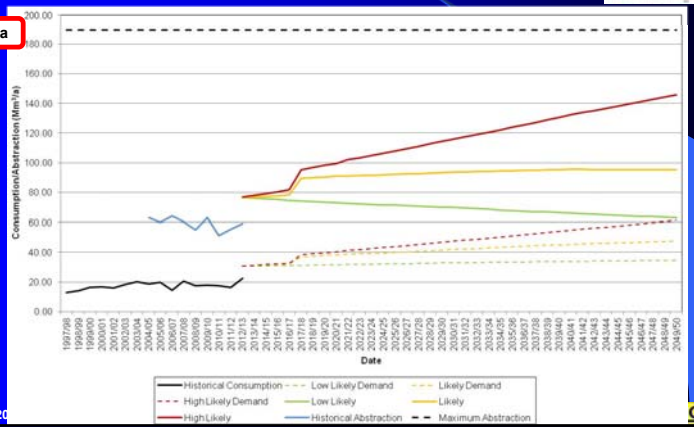
THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.6 WATER DEMANDS & SUPPLY
3.6.3 Abstraction Requirements at Calueque



189 Mm³/a



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.7 SUMMARY: CURRENT SITUATION

- Phase I (assessments of water resources & demands): complete
- The Kunene River should have sufficient supply capacity:
  - 2050 Required abstraction < 6 m³/s allowable
  - 95% Yield: 19.3 m³/s
  - Monthly flow has in the past been < 31.10 Mm³/m (6 m³/s x 2) (?)
  - → Need for storage provision (?)
- No redundancy of supply: Single point and source of supply
- Geopolitical concerns
- Future development unknown, water quality may deteriorate

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

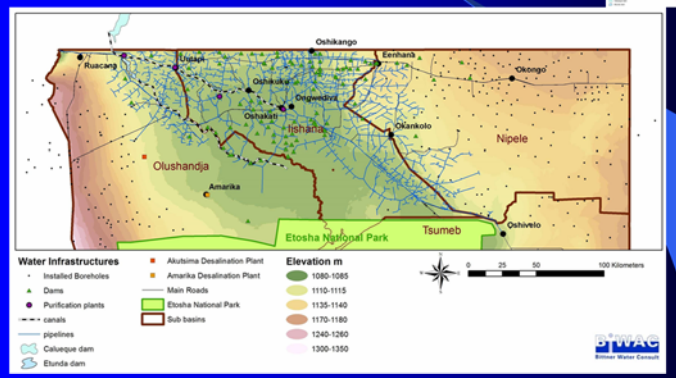
3. THE CUVELAI AREA OF NAMIBIA
3.8 WATER SUPPLY OPTIONS

1. Groundwater resources to the east and west of the area

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

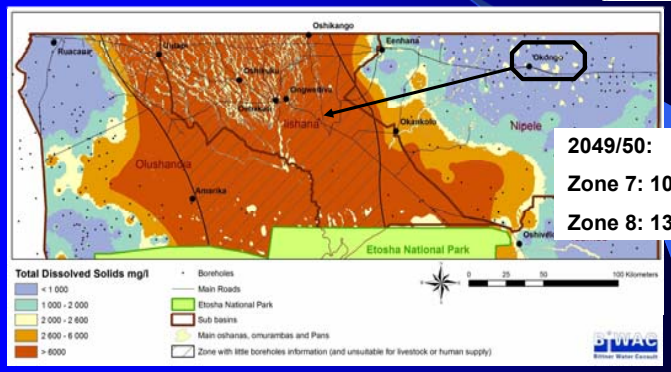
3.8 WATER SUPPLY OPTIONS
3.8.1 Groundwater in the Cuvelai Area



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.1 Groundwater in the Cuvelai Area



2049/50:

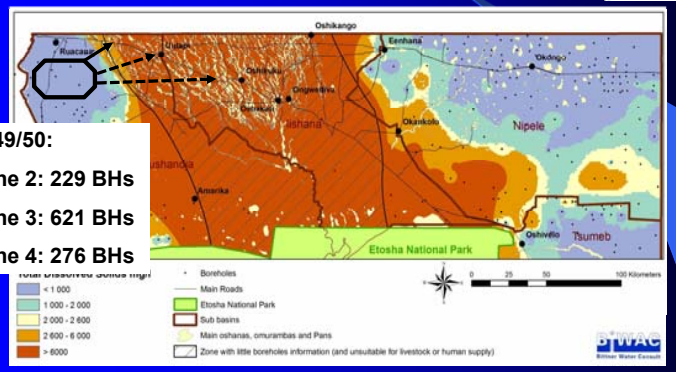
Zone 7: 103 BHs

Zone 8: 131 BHs

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.1 Groundwater in the Cuvelai Area



2049/50:

Zone 2: 229 BHs

Zone 3: 621 BHs

Zone 4: 276 BHs

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

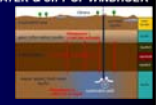
3. THE CUVELAI AREA OF NAMIBIA
3.8 WATER SUPPLY OPTIONS

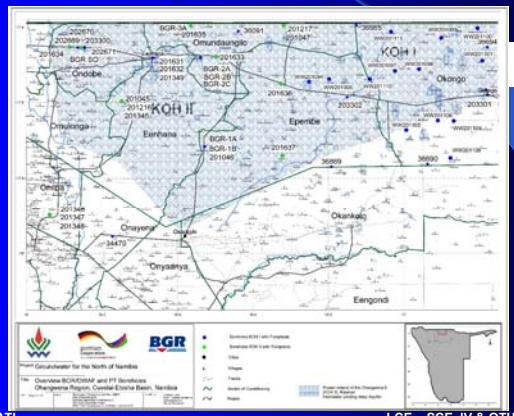
1. Groundwater resources to the east and west of the area: Insufficient
2. Water reclamation and reuse: Non-potable reuse
3. Surface water sources, incl. Lake Oponono: Not feasible
4. Desalination of saline ground water: Investigations underway
5. Ohangwena II Aquifer: Investigations underway

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer



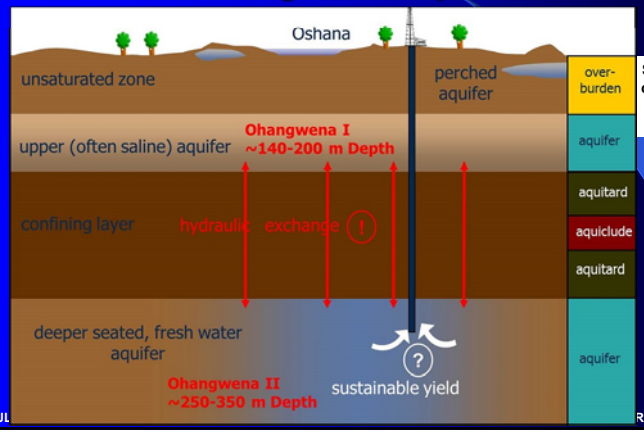


Extent
BGR, 2014

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer

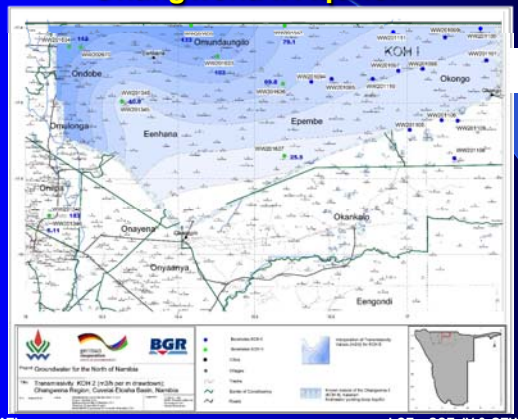


Schematic Layout of the Ohangwena Aquifers (after BGR, 2013)

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer

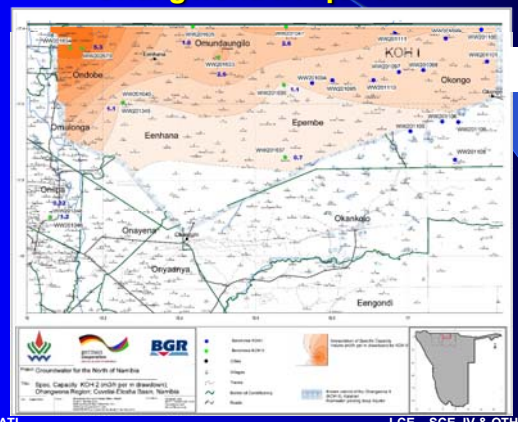


Transmissivity (BGR, 2014)

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer



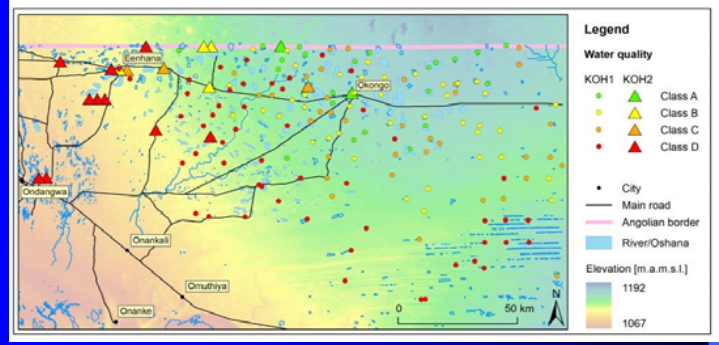
Specific Capacity (BGR, 2014)

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer

Water Quality for Human Consumption (BGR, 2014)



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

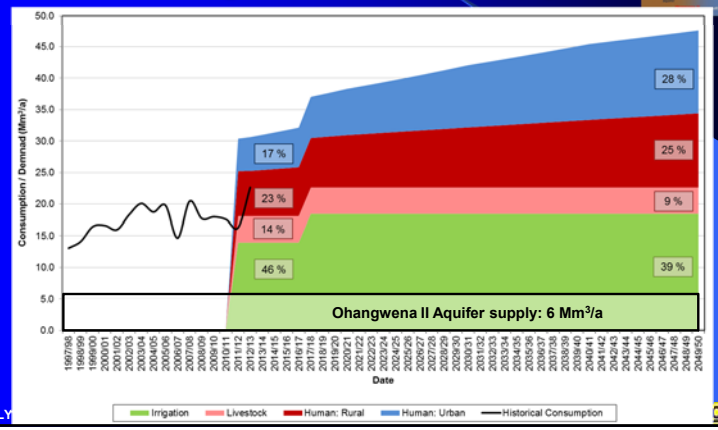
3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer (BGR, 2014 & 2015)

- Area: 5,170 km²
- Depth: 189 – 372 m below surface; average: 235 – 305 m
- Average thickness: 65 m
- Stored volume: 20.68 billion m³ (40 m thickness)
- Potential sustainable abstraction: 6 Mm³/a
- ± 30 Boreholes @ 30 m³/h each; N$ 30 million (BHs only)
- Potable water demand: 2013: 16.68 (12.53) Mm³/a ~ 36% (47%)
  2050: 29.15 (24.99) Mm³/a ~ 21% (24%)
  (Human demand only)

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

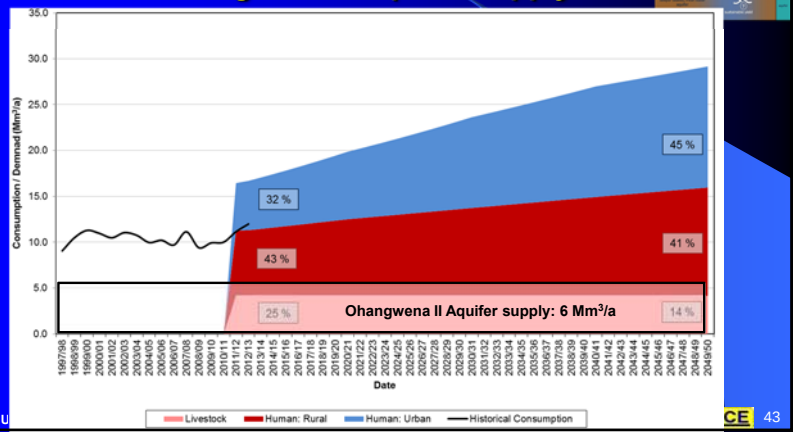
3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer Supply



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.5 Ohangwena II Aquifer Supply



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.8 WATER SUPPLY OPTIONS

1. Groundwater resources to the east and west of the area: Insufficient
2. Water reclamation and reuse: Non-potable reuse
3. Surface water sources, incl. Lake Oponono: Not feasible
4. Desalination of saline ground water: Investigations underway
5. Ohangwena II Aquifer: Investigations underway
6. Abstraction from the Kunene River at Ruacana: Investigations underway

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.6 Abstraction from Ruacana

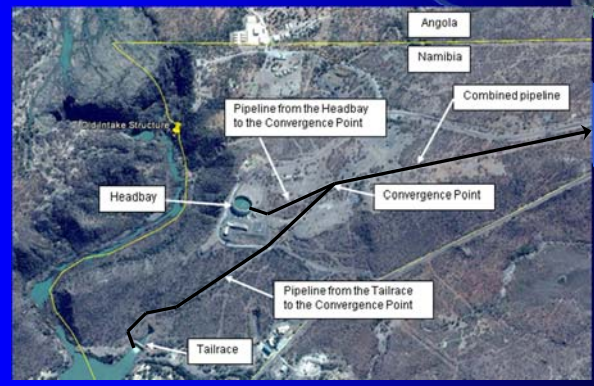
Photograph by Wolfgang Hanko (Panoramio)

Photograph by Naglwitz (Panoramio)

THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

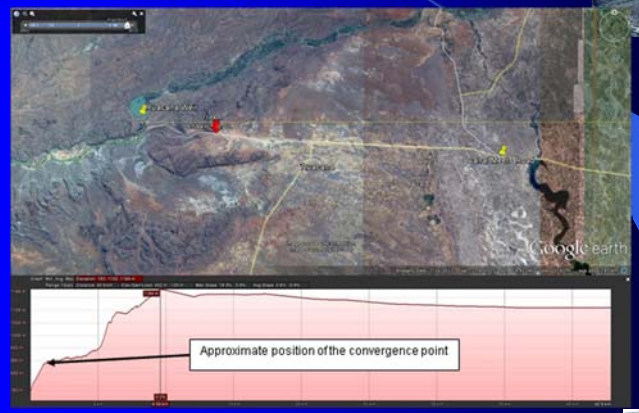
3.8 WATER SUPPLY OPTIONS
3.8.6 Abstraction from Ruacana



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

CUVELAI

3.8 WATER SUPPLY OPTIONS
3.8.6 Abstraction from Ruacana



THE AUGMENTATION OF WATER SUPPLY TO THE CAN AND CUVELAI:
SUMMARY PRESENTATION: CAN & CUVELAI
MAWF (DWAF), NAMWATER & CITY OF WINDHOEK

3. THE CUVELAI AREA OF NAMIBIA
3.8 WATER SUPPLY OPTIONS

1. Groundwater resources to the east and west of the area: Insufficient
2. Water reclamation and reuse: Non-potable reuse
3. Surface water sources, incl. Lake Oponono: Not feasible
4. Desalination of saline ground water: Investigations underway
5. Ohangwena II Aquifer: Investigations underway
6. Abstraction from the Kunene River at Ruacana: Investigations underway
7. Abstraction from the Okavango River (?)

- ❖ Public participation
- ❖ Infrastructure upgrades required
- ❖ Costing and other evaluations: Phase 3