

National Workshop on Cost-effective Boreholes



***Khartoum, 18th-19th Nov 2009
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WaterAid UK***

Drilling Cost Estimation and Cost-saving Analysis



Acknowledgments

Ethiopia study and WSP Field Note: Gov^t of Ethiopia, WSP, RWSN, UNICEF

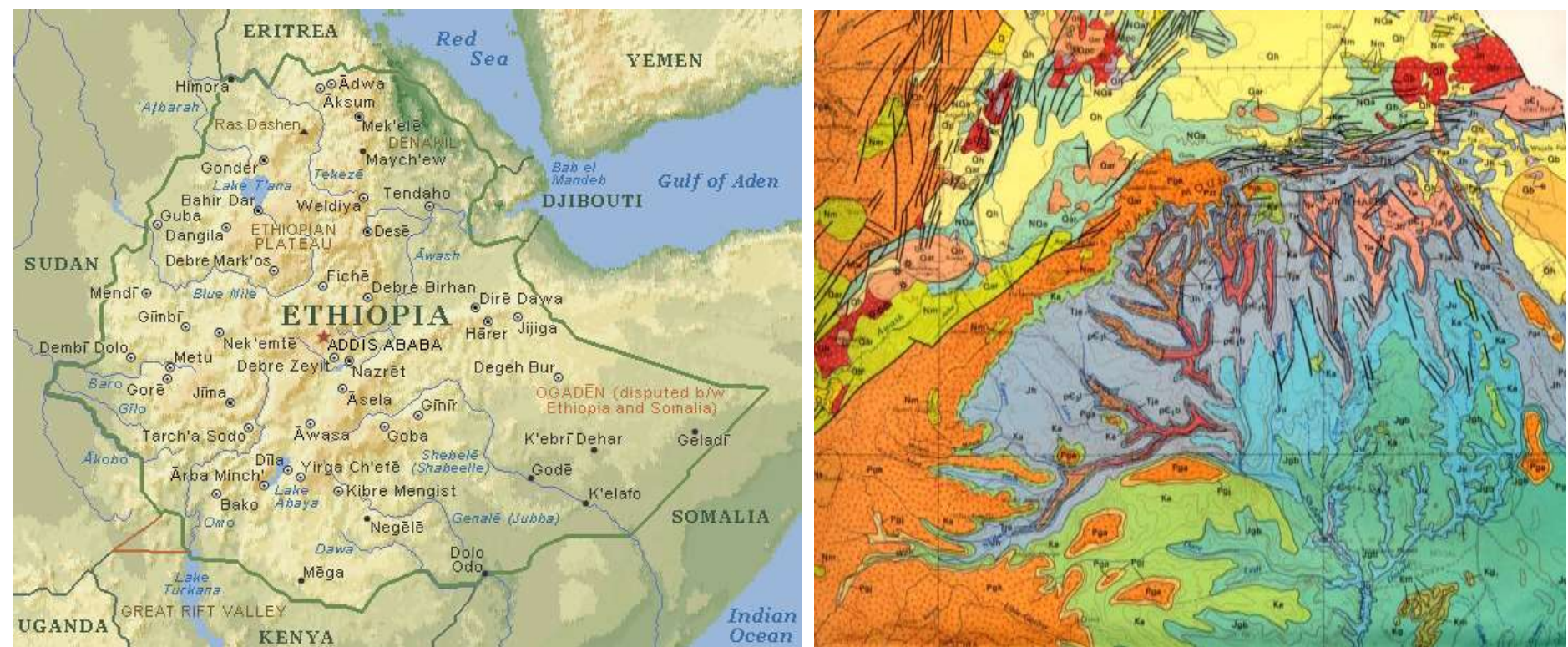
Flagship on Cost-effective Boreholes: RWSN/SKAT Kerstin Danert, Erich Baumann

Costing, modelling & analysis: Etsegenet Berhe, Tom Heath, Philip Tibenderana

Drilling sector expertise & costing methods: Ray Rowles, Peter Wurzel, Peter Ball

The Ethiopia Drilling Sector Study

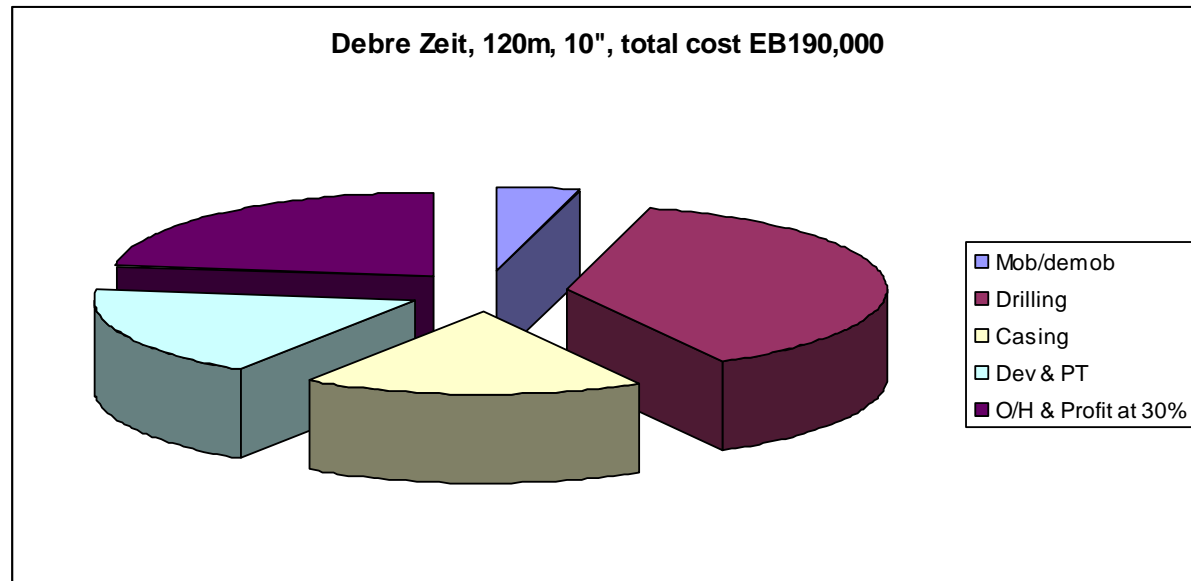
A major study of the state of Ethiopia's drilling sector, completed 2006, with a strong emphasis on costs and cost-reduction opportunities.



The Ethiopia Drilling Sector Study

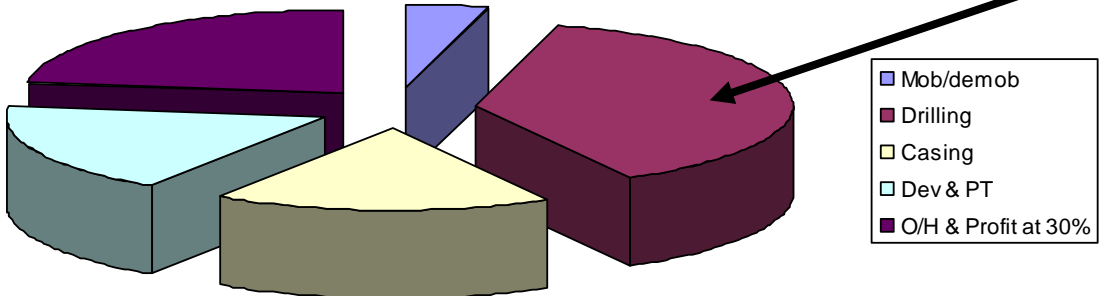
Cost breakdown by

- Mobilisation
- Drilling
- Completion
- Development & test pumping
- Overheads & profit



No two boreholes are the same

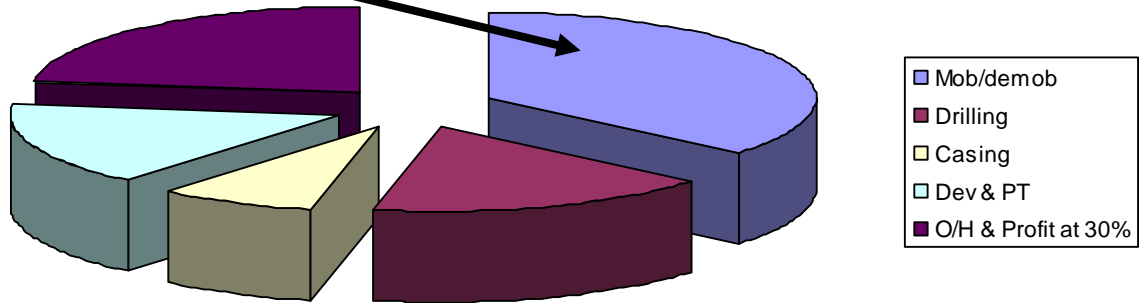
Debre Zeit, 120m, 10", total cost EB190,000



Near Addis, single biggest component is drilling

Long distance from base, single biggest component is mobilisation, and total cost is twice as much.

Adigrat, 120m, 10", total cost EB417,000



Successful wells, dry wells

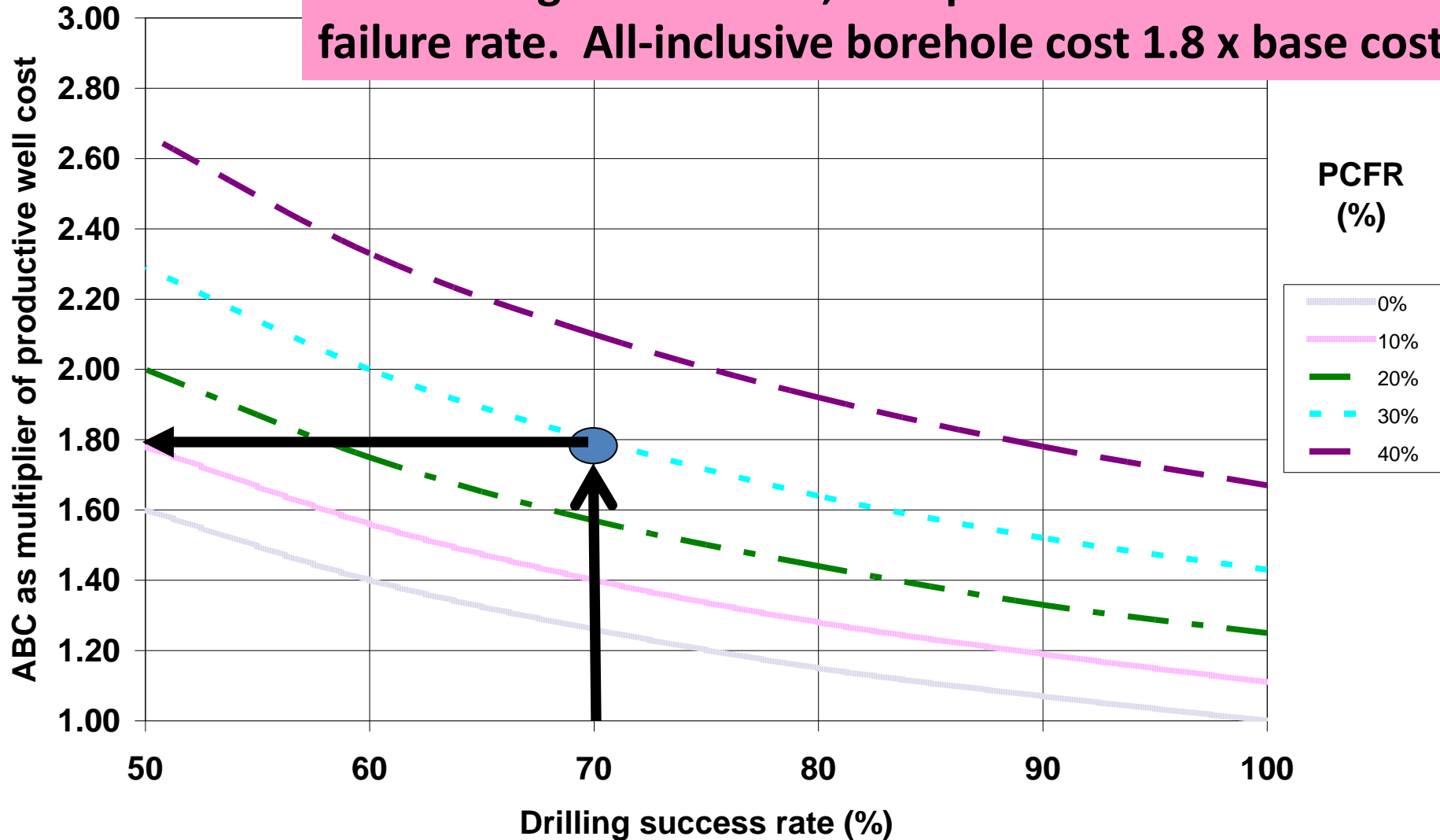
Successful well			Dry well	
• mob	31,000	—————→	31,000	
• drilling	72,000	—————→	72,000	
• casing	32,000			
• dev/ PT	39,000			
• TOTAL	174,000		• TOTAL	103,000 [60% of SW]

[EB, excl overheads & profit]

Wells fail at drilling stage, and post-construction

Failed wells represent a major cost

70% drilling success rate, 30% post-construction failure rate. All-inclusive borehole cost 1.8 x base cost

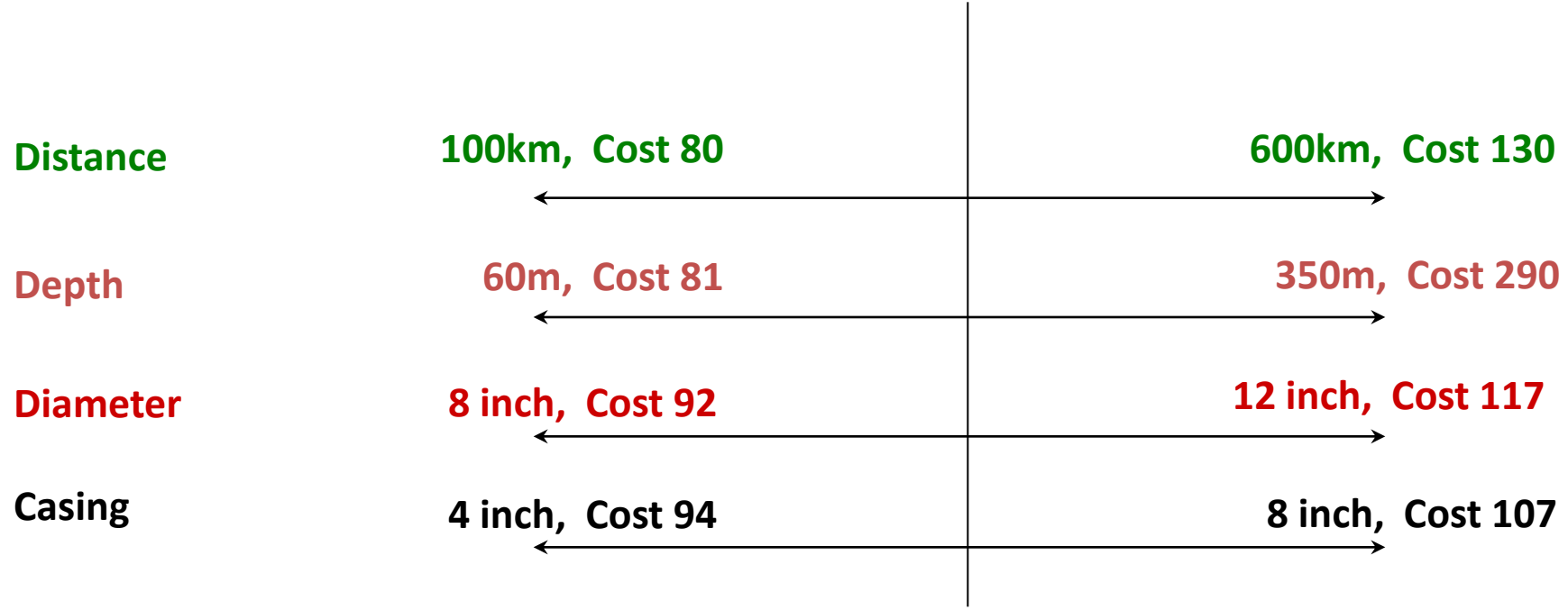


Borehole costs: simple sensitivity analysis

Changing one parameter at a time ...

Example

Distance:	300km
Depth:	100m
Diameter:	10 inch
Casing:	6 inch
Cost	100 Units



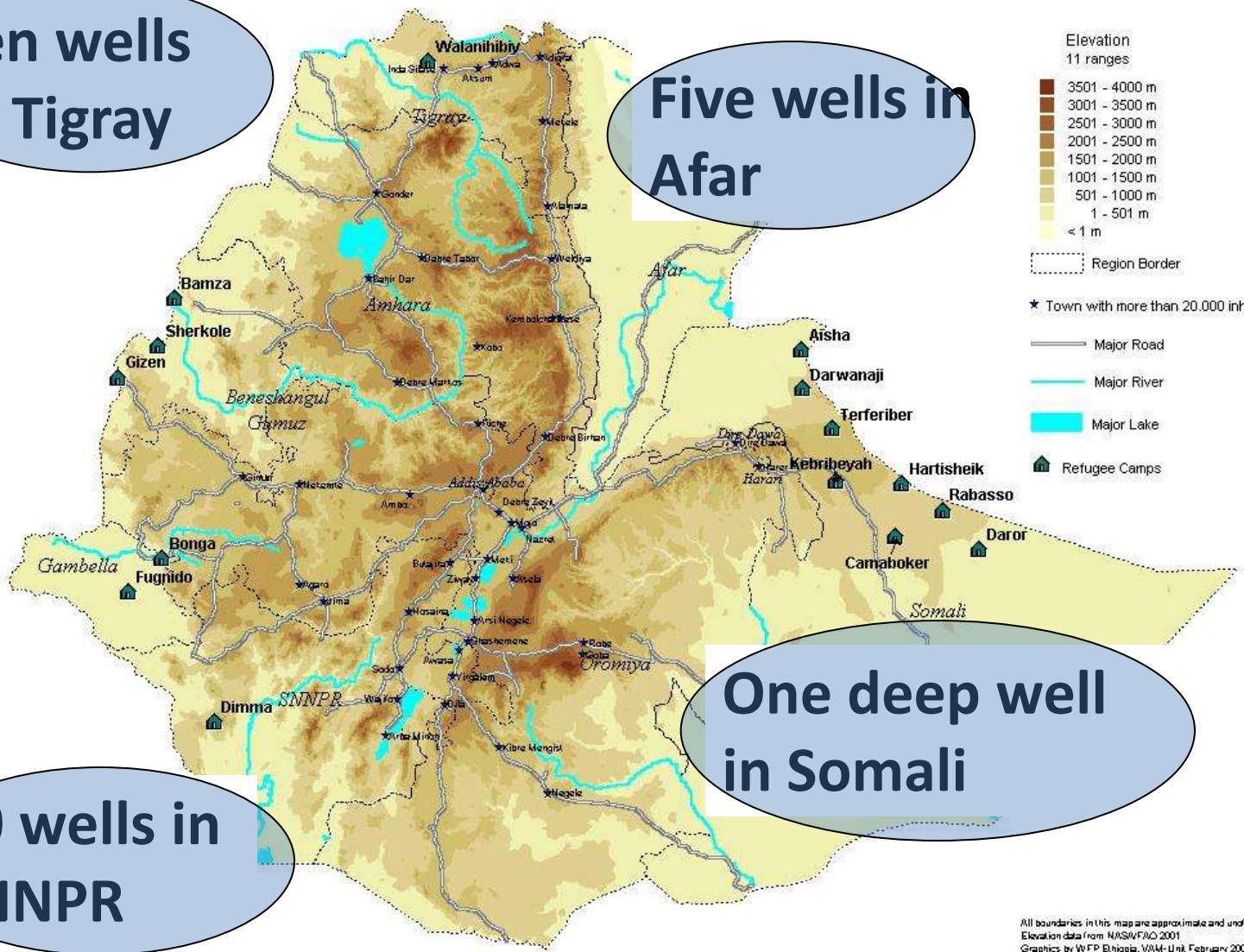
Scenario analysis: from single well to multi-well projects

Ten wells in Tigray

Five wells in Afar

One deep well in Somali

50 wells in SNNPR



All boundaries in this map are approximate and unofficial.
Elevation data from NASA/FAO 2001
Graphics by WFP/Ethiopia VAM-Unit February 2001

The “Ten-Steps” Field Note



October 2006

Field Note

Rural Water Supply Series

Ten-step Guide Towards Cost-effective Boreholes

Case study of drilling costs in Ethiopia

Increasing access to groundwater is a high priority for sub-Saharan Africa. One key to this is to reduce the costs of conventional drilling and borehole construction. This field note, describing a recent study in Ethiopia, sets out some of the ways in which this may be done.



Synthesis of sector know-how, making qualitative arguments

1. Borehole design fit for purpose
2. Smaller rigs
3. Packaged (multi-well) contracts
4. Better knowledge and siting
5. Test pumping fit for purpose
6. Improved supervision
7. Evaluation of water resources
8. Sustainable O&M strategies
9. Support to the private sector
10. Improved networking and skills

Analysing drilling costs

Costs and prices: a fundamental challenge

- **Cost** – expenses directly incurred by the driller
(equipment, labour, materials, consumables, loan repayments, taxes, office overheads, legitimate and other transaction costs)
 - **Price** – the amount paid by the client
(cost + profit + risk mark-up + ...)
-
- **Cost** – known (?) by the contractor
(Do all contractors know what their activities really cost?)
 - **Price** – tendered and ultimately paid
(Do clients know the relationship between prices and costs ?)

Getting to the root of costs – a modelling approach

Why model costs? Because ...

- this is what good contractors should be doing
- this is what intelligent clients should be doing
- tendered price is not a good guide to real cost
- greater transparency about costing may also lead to price reductions



The drilling cost model v2.5

- Based on work of Etsegenet Berhe (contractor) in Ethiopia – team member, Ethiopia CEB study
- Further work by Kerstin Danert, RWSN/SKAT
- Formulated by Tom Heath* and Philip Tibenderana*, Cranfield University, 2009
- Sensitivity analysis by Heath and Tibenderana
- Available for testing and evaluation January 2010

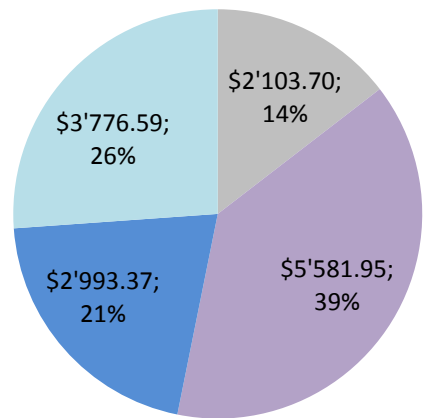
*Supervised by Prof Richard Carter

The drilling cost model v2.5

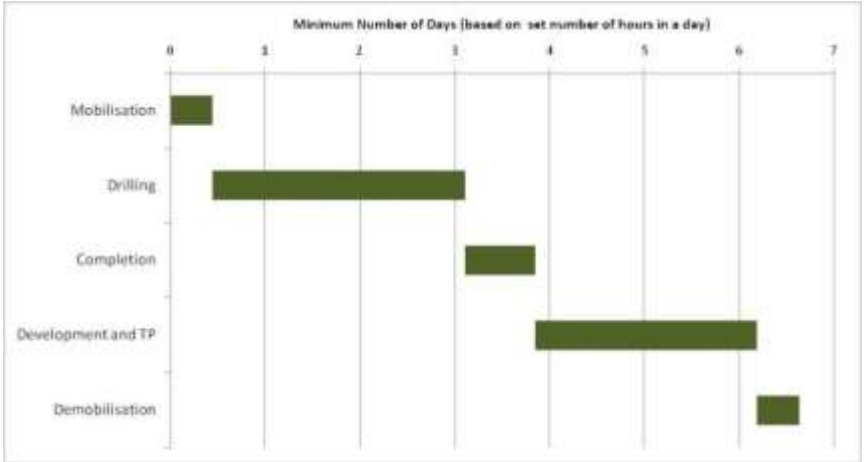


- **Base costs:** user database of locally/regionally specific data on rigs, vehicles, labour costs, fuel and consumable costs ...
- **Borehole details:** user-entered borehole design data
- **Results:** bill of quantities and Gantt chart

Example model outputs



■ Mobilisation ■ Drilling ■ Completion ■ Development



USD Bill of Quantities

No	Description	Unit	Unit Rate	Quantity	Amount (\$)
1	Mobilisation/Demobilisation				\$2,104
1.1	Rig Depreciation	\$/hour	\$19.28	8.00	\$154
1.2	Fuel	km	\$2.71	200.00	\$541
1.3	Vehicle running costs	per day	\$132.00	6.63	\$875
1.4	Labour: Mobilisation	hours	\$66.67	8.00	\$533
2	Drilling				\$5,582
2.1	Per Hour:				
2.11	Drilling + Rig Depreciation	\$/hour	\$28.24	20.00	\$565
2.12	Labour: Drilling	\$/hour	\$66.67	20.00	\$1,333
2.13	Compressor Fuel	\$/hour	\$59.95	20.00	\$1,199
2.14	Rig Fuel	\$/hour	\$19.95	20.00	\$399
2.15	Mud & foam	\$/hour	\$20.00	20.00	\$400
2.16	Length of Delays	\$/hour	\$217.95	4.00	\$872
2.2	Per Metre:				
2.21	Rock Drilling Costs	m	\$8.57	20.00	\$171
2.22	Overburden Drilling Costs	m	\$8.03	80.00	\$643
3	Casing and Completion				\$2,993
3.1	Casing: 6 inch casing	m	\$21.60	60.00	\$1,296
3.2	Screen: 6 inch screen	m	\$23.70	30.00	\$711
3.3	Backfill	m	0.00	73.00	\$0
3.4	Gravel Pack	m	\$12.84	24.00	\$308
3.5	Sanitary Seal	m	\$3.00	35.00	\$105
3.6	Labour: Casing	\$/hour	\$66.67	6.67	\$444
3.7	Rig Depreciation	\$/hour	\$19.28	6.67	\$129
4	Development and Pumping Test				\$3,777
4.1	Borehole Development (Compressor Running)	\$/hour	\$59.95	12.00	\$719
4.2	Pumping Test (Pump and Generator Running)	\$/hour	\$19.95	24.00	\$479
4.3	Labour Development and Test Pumping	\$/hour	\$66.67	30.00	\$2,000
4.4	Rig Depreciation	\$/hour	\$19.28	30.00	\$578
	Total (excluding overheads)				\$14,456
	Total (including overheads)				\$14,575

Analysing cost saving opportunities

Uganda case study

Base case single borehole

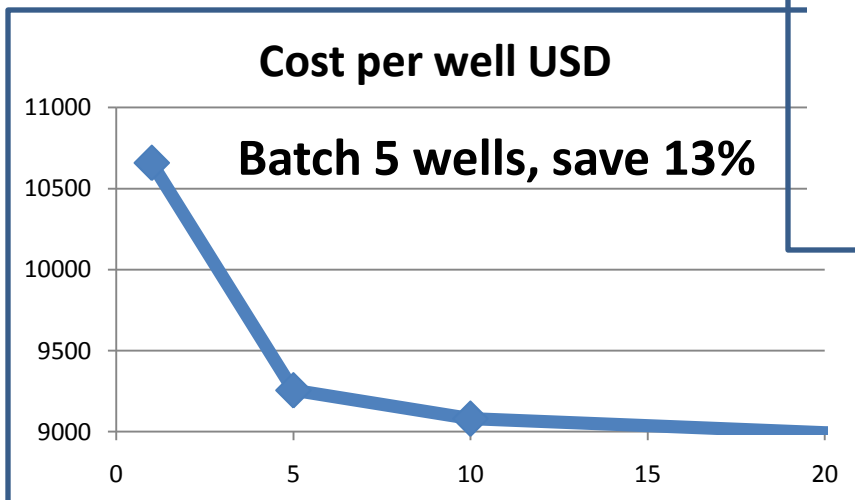
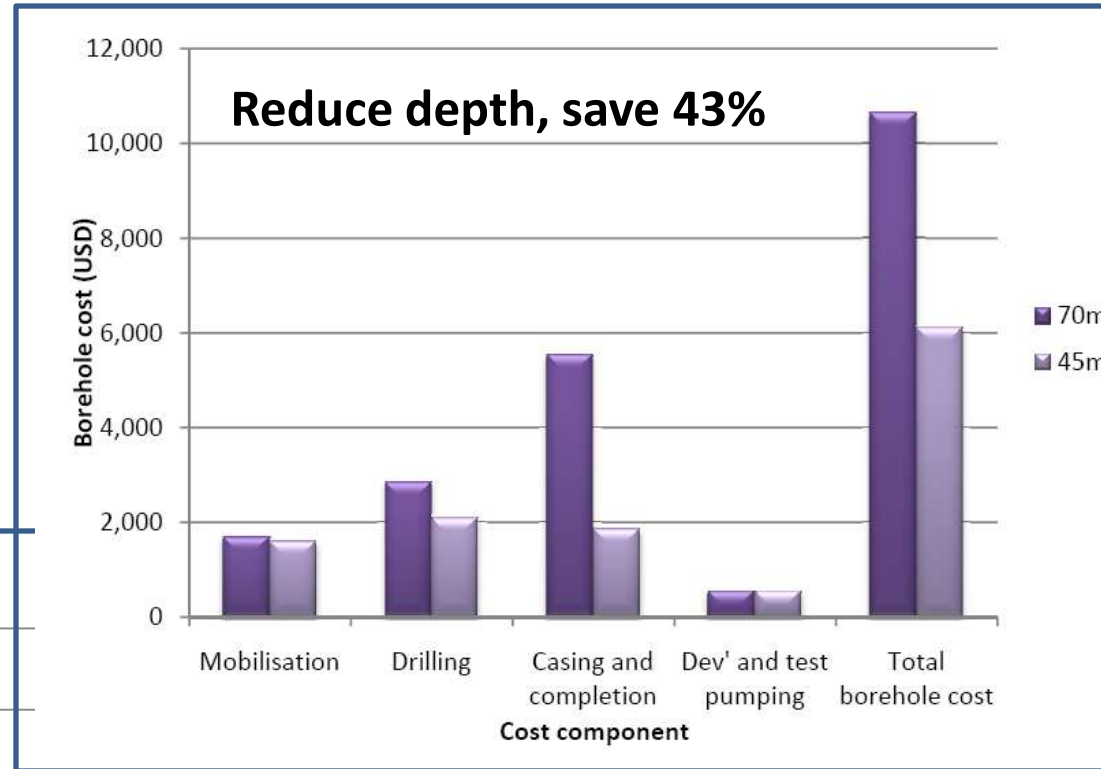
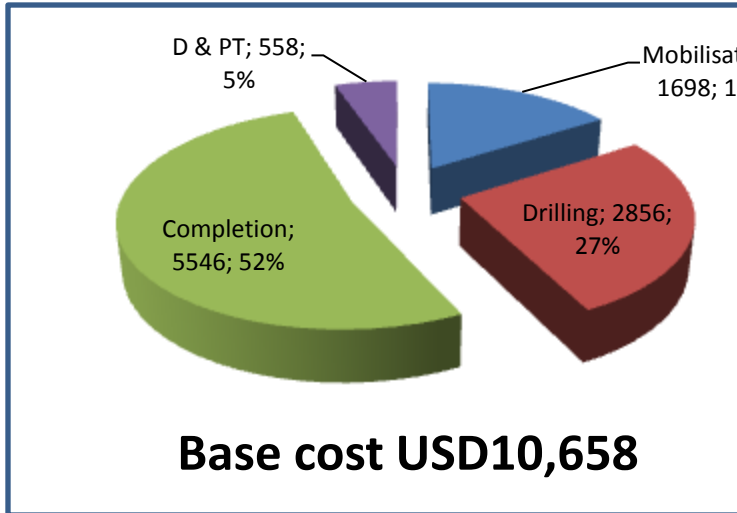
- Location 200km from Kampala
- Depth 70m
- Diameter 10 $\frac{5}{8}$ inch
- Cased/screened 6 inch

Variables investigated

- Depth
- Diameter
- Rigs
- Multiple wells
- Test pumping duration



A Ugandan application of the model



Example results

Next steps

Costing model

- Further testing, refinement and use by contractors and clients
- Availability January 2010

Re-visiting the “ten steps”: policies, practices and professionalism

- Hydrogeological and groundwater resource knowledge
(improving drilling success rates and reducing post-construction failure)
- Construction supervision
(quality assurance, reducing post-construction failure)
- Operation and maintenance
(reducing post-construction failure)
- Enabling environment for private sector
(freer business environment enables cost-saving)

Raising professional standards in the sector

Towards sustainable services for all

