ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED AGRICULTURE PROJECT ON DHANDHOO, BAA. ATOLL

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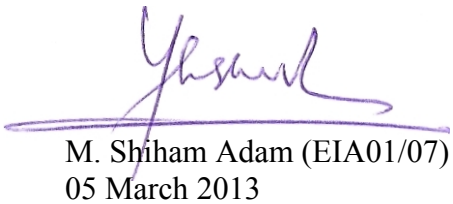
Declaration of the Consultant:

I certify that the statements made in this Environmental Impact Assessment are true, complete and correct to the best of my knowledge and available information at the time of writing this report.



M. Shiham Adam (EIA01/07)
05 March 2013

Acronyms used in the text

CAM	Complementary and Alternative Medicine
DNP	Department of National Planning
EPA	Environmental Protection Agency
MBR	Membrane Bioreactor
MHTE	Ministry of Housing, Transport and Environment
MoFA	Ministry of Fisheries and Agriculture
MoEE	Ministry of Environment& Energy
MoTAC	Ministry of Tourism, Arts and Culture
MPL	Maldives Ports Limited (a state-owned enterprise)
MRC	Marine Research Centre
MSL	Mean Sea Level
NPC	National Planning Council

1 NON TECHNICAL SUMMARY

1. ބ. އަތޮޅުގެ ދަނޑުވެރިކަމުގައިވާ ހަނިފަރާ 2008 ވަނައަހަރު ކުރީކޮޅުގައި މ. ސަނީސައިޑް، އަލިފާނުވިލ މުބާރަކު ޝަރީފް އަދި ދަނޑުވެރިކަމުގެ ތަރައްޤީ މަޝްރޫޢު ހިންގުމަށް މިނިސްޓްރީ އޮފް ފިޝަރީޒް އެންޑް އެގްރިކަލްޗަރ އިން ލީސްއަށްދޫކޮށްފައިވާ ރަށެކެވެ. ނަމަވެސް، 2009 ގެ ކުރީކޮޅުގައި، ރަށުގައި މަސައްކަތް ފެށުމުގެ ކުރިން ހަދަންޖެހޭ ތިމާވެށީ އަސަރުފާހަގަ ކުރުމުގެ ރިޕޯޓް ހެދުމަށް އެންވަޔަރަމަންޓަލް ޕްރޮޓެކްޝަން އެޖެންސީއަށް ހުށަހެޅުމުން އިޢުލާނު ސްކޯޕިންގ މީޓިންގ އަދި ޓީއޯއާރު ނެރުމަށް، އޭގެ މިނިސްޓްރީ އޮފް ހައުސިންގ އެންޑް އެންވަޔަރަމަންޓްގެ ހުއްދަ ހިމާޔަތް ކުރުވައިފައިވާ ސަރަޙައްދެއް ކަމުގައި ކަނޑައެޅުއްވިއެވެ. އަދި އޭގެފަހުން ހުއްދަ(ދަރަނި) ލިބި ހިމާޔަތް ކުރުވައިފައިވާ ސަރަޙައްދެއް ކަމަށް ކަނޑައެޅުއްވިއެވެ. މިހެންވުމާއި ސަރުކާރުން މިކަމާބެހޭ ގޮތުން މަޝްވަރާކުރުމަށްފަހު މިނިސްޓްރީ އޮފް ފިޝަރީޒް އެންޑް އެގްރިކަލްޗަރ އިން ހުއްދަދީފައި ވާތީ ބ. ދަނޑުވެރިކަމުގެ ތަރައްޤީ މަޝްރޫޢު ހިންގުމަށް ބ. ދަންދޫއަށް. ދިމާ، ތިމާވެށީ އަސަރުފާހަގަ ކުރުމުގެ ރިޕޯޓް ހެދުމަށް ބ. އަތޮޅު ދަންދޫގައި ދަނޑުވެރިކަމުގެ ތަރައްޤީ މަޝްރޫޢު ތިމާވެށީ ގޮތުން ހުއްދަ ދިނުމަށް ރިޕޯޓް ތައްޔާރުކުރެވިފައި ރިޕޯޓްކޮށްފައެވެ.

2. ދަންދޫއަކީ ބ. އަތޮޅުގެ އިރު އުތުރު ބިމުގައި އޮންނަ ވަކިރަށެއް ކަމުގައިވާ އިރަވާދެ ހުޅަނގު (ރީފް ޖެހިގެން)ގެ ދެކުނުން އޮންނަ ކުޑަ ރަށެކެވެ. ރަށުގެ ހުރިހާ ބިމުގެ ބޮޑުމިނަކީ ރަށުގެ ބޭރުވަށައިގެން އޮންނަ 2.3 ހެކްޓަރެވެ. ނަމަވެސް ގޭގެއްގެ ބޭރުގައި ހިއްސާކުރަން ހުރިހާ ނަމަލިބޭ ރަށުގެ ބިމުއާރަފި 9.2 ހެކްޓަރެވެ. ވަށައިގެން ދަނޑުވެރިން އޮންނަ މިދެރަށުގައި ހުރިހާ ފާހަގަ ފެނުނު ރަށުގެ ބޭރުރަށް ދެތުން ހުރިހާ ޓެކްނިކަލް ކަންކަމާއި މިބުނި ހުޅަނގު ފަރާތު މުޅިތެރެ ބޭރުފަރު މިފަދަ ފަސް 15-20 މީޓަރެވެ. ނަމަވެސް އެތެރޭގައި، އިނގޭ އަދި ދިރާސާ ފަރާތް ފަރާތުގެ ބޭރުފަޅު ދެކުގައި ތިމާވެށިއަށް ކުރާ އަސަރު މިހާރު ރިޕޯޓްގައި ބޮޑަށް ހިމެނޭ ޕްރީ ކޮންސްޓްރަކްޝަން ރިޕޯޓްކުރެވޭ ގޮތުގައި އިމާރާތް ކުރަން ތިމާވެށި ފަދަ ބ. އަތޮޅުގައި ހިމެނޭ މިރަށުގެ ކަނޑުގައި 5 ރީފްތަކެއް ވެއެވެ. އެއީ ޕާރަސްކޯޕް، ކަރަންޓް، ހިމި ބިލް، ފަރުގެ ބޭރުފަޅު، އަދި ވަރަށް ފަރުން ހުސްވަނީ ކަނޑުގެ ދަށުގައިވާ ރީފްތަކެވެ.

3. ދަންދޫ ކުރީގައި ދިރިއުޅުނު ފަރާތެއް ޖަހާފައި އަލިފާނުގެ މުބާރަކު ޝަރީފް އެވެ. އެރަށުގައި ކުރިމަތިވެފައިވާ ހުރިހާ ކަމެއްގައި ތަފާތު ނިޒާމުތަކެއް ހުރިކަމަށް މަސައްކަތްކުރެވެ. އެގްރިކަލްޗަރ ކުރުމުގެ ޕްރޮޖެކްޓްތަކަށް ހުރިހާ ކަމެއް ގޮތުގައި ހޯދުމަށް ސިސްޓަމެއް އެއީ ހައިޑްރޯޕޯނިކްސް ޕްރޮޖެކްޓުގެ ތިމާވެށްޓާ ބައްލަވާ (ނެޓްރި ކެނައްޖެ ސިޓީރީޖް) ދަނޑުވެރިކުރުމެވެ. މިގޮތުން ގްރީންހައުސް 4000 އަކަފޫޓުގެ 6 ގްރީންހައުސް ތަރައްޤީކުރުމަށް ރާވާފައިވެއެވެ. މިއީ ބޮޑުން ގެނައުން އަދި ރާވާފައިވާ ގޮތުގެ ކުރިން ގެއިން ހައްޓަވާ ހައިޑްރޯޕޯނިކްސް އާއި އޮތް ޕޮޓް ބޮޑުން ޕްރޮޖެކްޓްގެ ގްރީންހައުސް ހަދާފައި ވާތީ ގުޅޭ ފަސްކެޔޮ ބޮޑުން ޕްރޮޖެކްޓުތަކާ ނޭޗަރަލް ގޮތެއް ބާވަތުގެ ޕްރޮޖެކްޓެއް ގްރީންހައުސް ޕްލޭން އަދި ގްރީންހައުސް ޖަހާ ބާވަތް ފައިބަރ ދިއުމުގެ ފުރިހަމަ ހަރުކަށި ހަލާކުނުވާ ބާވަތެއް ކަމަށް ބުނެވެ. އެއިރުން ދަތުރުފަތުރު ބަލާފައި ބޭނުމަށް އެއްގަމުގައި މިކަމަށް ރާވާފައި ހުރީ ގެދޮރު ހަމަޖެހޭގޮތަށް ހިފެހެއްޓުމެވެ. މަސައްކަތް ކުރާގޮތް ތިމާވެށްޓާ ދުރުގައި ހުރިހާ ފަރާތްތަކުގެ ބޭނުމަށް އިންވެސްޓްމަންޓް އަކަފޫޓު ވަރަށް ގިނަ ކަމެކެވެ. އެއީ ކަށިކީ ކަމެއްކަން މިހާރުވެސް ކަރަންޓް ކަރަށް ދަނޑުވެރިކަމުގެ ކަމުގައި މި ދަނޑުވެރިކަން ކުރަން ދެބައިކުރެވިފައި ހުރިކަން ހިފެހެއްޓުމަކީ ދިމާވާނެ ކަމެކެވެ.

4. އެގްރިކަލްޗަރ އިތުރުން ދަންދޫގައި ދިވެހިބޭސްފަރުވާގެ ކްލިނިކެއް ގާއިމުކުރުމަށް ހުށަހަޅައެވެ. އަދި ކްލިނިކާއި އެކު 4000 އަކަފޫޓުގެ ދިވެހި ބޭސްފަރުވާގައި ބޭނުންކުރާ ގަހާގެހި ނެތިގެންދާ ގަސްގަހާ ގެއްސާއި ފެހިފާލިޖުގެ ނާރިސަރީއެއް ތަރައްގީކުރުވާނެއެވެ. މި ނާރިސަރީގައި ގަސްތަކެއް ހެއްދުމާއި ޓްރޮޕިކަލް ޕްލާންޓްގެ ގޮތުގައެވެ. މިމަސައްކަތަށް ބޭނުންވާ ކްލިނިކުގެ އިމާރާތާއި 5 ފޫޓަށްވުރެ އުސްނޫން އެކޮމޮޑޭޝަން ބޭރުފަށް ގާއިމުކުރުވާނެއެވެ. މިމަސައްކަތަށް އެގްރިކަލްޗަރ މަސައްކަތާއި ފަރުވާކުރުމަށް ރާވާފައިވާ ދުވަސް ފިޔަވައި ބާކީ ދުވަސްތަކުގައި ޓޫރިޒަމް ކުރިއަރުވާލެވޭނެއެވެ. މިމަސައްކަތް ކުރިއަށް ގެންދެވޭނީ ރާއްޖޭގައި ދިވެހި ބޭސްފަރުވާ ދަސްކޮށްދޭ ފަރާތްތަކުގެ ބެލުމުގެ ދަށުންނެވެ. އިސްވެދަންނަވާފައިވާ އެގްރިކަލްޗަރ މަސައްކަތާއި ބޭސްފަރުވާގެ ހިދުމަތް ދިނުމުގައި ދަންދޫގައި ދާއިމީގޮތުގައި ވަޒީފާ ދެވޭނީ 15 މުވައްޒަފުންނެވެ.

5. ރަށުގައި ފެންއާލާކުރާ ޕްލާންޓެއް ކަރަންޓު އުފެއްދުމަށް ޖެނެރޭޓަރެއް ބެހެއްޓުމެވެ. މިކަންކަމަށް ބޭނުންވާ އެކަނިވެރިވާ އިމާރާތް ގާއިމުކުރުވާނެއެވެ. ފެން ޕްލާންޓްގެ ކެޕޭސިޓީއަކީ އެއްދުވަހު ދިނުމަށް ދުވާލަކު 10 ޓަނެވެ. އަދި އިލެކްޓްރިކް ޖެނެރޭޓަރުގެ ކެޕޭސިޓީއަކީ 25 ކިލޯވޯޓެވެ. ފެންޕްލާންޓަށް ފެންނެގޭނީ މޫދުންނެވެ އަދި ބްރައިން ނުވަތަ ރިޖެކްޓް ފެން އުކާލާނީ ވެލްސް ވަޅަކުންނެވެ. ރަށުގައި އުފެއްދޭ ކަރަންޓު ބޭނުންކުރާނީ ޕާމްގެ ކަންތައް ފޯރުކޮށްދިނުމަށް ރަށުން ބޭރުކުރާނެ ބޭ. އެބިޔަފާ ގާއިމުކުރަމުގެ ކުރިން ނަލަހަމަ މިސާލަކަށް ޓޯޗު ކަރަންޓުގެ ކޮންސަމްޕްޝަން ކުރިއަށް. ދަނޑުވެރިކަމުގެ މަސައްކަތްތަކުގެ ބޭނުންކުރާނީ ގަސްކަނޑާއި އިލެކްޓްރިކް ޖެނެރޭޓަރ އަދި ބޭނުންވާ ޖާގަ އަދި ވާރޭފެން ގެއްލުން ދަނިވި ބާވަތްތަށް ބެހެއްޓުމާއި ބެލެހެއްޓުމުގައި ރައްކާތެރިކަމާއި ދިމާކުރެވޭ.

6. މިމަސައްކަތް ކުރުމަށް ކުރަނޑު ހިފާއިރު ގަނޑުރަށާއި ގުޅޭ ހިސާބުތަކުގެ ރަށުގެ ފައިބާފުދާލުން ފާހަގަ ކުރުމަށެވެ. މިމަސައްކަތް ކުރުމަށް ބިންސާފުކުރުމުގައި 60-80 ރުކު ކަނޑާލަން ޖެހޭނެއެވެ. އަދި އެސަރަހައްދުގައި ހުރި އެހެނިހެން ގަސްތަކާއި ފުއްޕާ ނަގާ ބިންސާފުކުރަން ޖެހޭނެއެވެ. އުސްފުށުގެ ގޮތުން ކަނޑުހުން ކަނޑާލަން ރުކާއި ބުރުސް ނުކަނޑާނެއެވެ. އަދި މިކަމުގައި ހަމަޖެހިފައިވާ އުސްފުށުކަން ތަޅާ، ފުރިހަމަ ހިޔާ ރުއްކަށްވުރެ ބޮޑުއިން ކަނޑާ ކަނޑާ ރުކާއި ރުކާއި އަދި ގަހުގެ ގަޑުގެ އިންތިޒާމު ވަނީ ރާވާލެވިފައެވެ.

7. މަސްތޯތުގެ ލީޓަރު ސައިކަލްތަކުގައި ކުރުމަށްފަހުގެ ތަކެއްޗާއި ތިމާވެށިން އެކަމަކާ ބޭރަށް އަޅަނާނާ ހޫނުވާން ކަންކަމާއި ރަށް ތަޅާކަމަށް ގެނޮއްކަމަށް މަޑުކުރާ ތަކެއްޗަކީ ލޮދުކޮށްވެއްޖެކަމެވެ. ރަށުގެ ހުޅަނގުދިކުން ބޮޑު ސަލާމަތީ ރަށުގައި ހުރިތަން ދެ އެނދިރިން ޕައިސާއަކުން ގައިރު ވަށަނަ އިޚްލާޞްތެރިވާ ވަޅެއް ހަދާށެވެ. މިގެ ތަކެތިގައި ފައި ނިފާފޮން ކަރަފޮން، ފަސްކަނޑިދޫތަ، ރަށުގެ ބިންގަދު ފުންހިދުމަތްތަކާ ތަފާތުވަމުން ހިމެނެއެވެ. އަދި ރަށުގެ ފެހި ބޭއްމަސްގެ އެކަނިވެރިވާ ބަހައި މަތިވެ މާހައުލު ނިޒާމަށް އުނިކަމެއް އަރުން ހިމެނެއެވެ.

8. މަސްތޯތުގެ ލީޓަރު ސައިކަލްތަކުގައި ދިގުމުއްދަތުގެ ތަކެތިގައި ފެއްޓޭ ކޯރަލް އަސަރުތަކުގެ ތަކެތިގައި އޮޑިޔަރު އައިސް ގޭސް ހުރުމުގެ ސަބަބުން ރަށުގެ ފަޅުތެރެއަށް ޕީސަލް /ފްލޯރާއިން ތަރައްޤީކުރުމާއި، ދަނޑުވެރިކަމުގެ މަސައްކަތުގައި ހައިޑްރޯކާބަން ނުވަތަ ބޭނުން ނުކުރުމުން ކައިރިކުރުމަށް ފެއްޓެން ޖަމާވާ ފާރާވާ ޓޮކްސިކް (ގަސްކާނާ) އަދި ރަސާޔަނިކް ހިމާޔަތް ފިހާއި މުށާފީ ތަކެތިކުރާ ގާތްގަނޑު އަސަރު ހިމެނެވެ. ނަމަވެސް، މިއިން ކޮންމެ ކަމަކީ ނިސްބަތުން މަދު އަދަދުތަކާއި ވުމުން މިކަންކަމުގެ ސަބަބުން ތިމާވެށިއަށް

ކުރާނެ އަސަރު ކުޑަވާނެ ކަމަށް ބެލެވެއެވެ. މިބޭނުމުން ކަންކަމުގެ ގެއްލުން ކުޑަކުރުމުގެ ގޮތުން ކުރެވިދާނެ ކަންކަން ރިޕޯރޓުގައި ފާހަގަކުރެވިފައިވާނެއެވެ.

9. ތަރައްޤީ މިމަޝްރޫޢު އާއި ގުޅިގެން ބ. އަތޮޅުގެ ކައުންސިލް ގެ ބޭފުޅުންނާއި ބައްދަލުކުރެވުނެވެ. އަދި ރިސޯރޓުތަކުން މިކަމުގެ ހިއްސާވެސް ހޯދުނެވެ. މިކަމަކީ ބ. އަތޮޅު ކައުންސިލުން ދުރުން އޮތީ ކަމެއް ކަމުގައި ބެލެވުނެވެ. އަދި މިރަށް ތަރައްޤީ ކުރުމަށް ހުރަހެއް ޕްރޮޖެކްޓުގައި މިފަދަ ބާއި ގެއްލުމެއް އެއްވެސް މަސައްކަތެއް ޢަމަލުކުރަން ފާހަގަކޮށް ނުކުރެވެއެވެ. ރިޕޯރޓުތަކުން ބޭނުމުވަނީ ވެއްޓިފައިވާ ދަނޑުވެރިކަމުގެ މަސައްކަތާއި ކުރުމަށް ތަރައްޤީ ކުރަމުން އަންނަ ތަށްކަމާއި އަދި ދަނދޫގެ ބިންގާނި ރަށުގެ މަގުމަތިން ނުފެނުނަ ވަރަށް ބެލެހެއްޓުމަކީ ރަނގަޅުވާނެކަމެއް ކަމުގައި ދެކޭކަމެވެ.

10. މިޕްރޮޖެކްޓް ތަރައްޤީގެ ޒިރާޢަތީގެ މަސައްކަތް ނިމި، އޮޕަރޭޝަން ޒިރާޢަތުގައި މިޤާފިލި މާހިބައި ކުރުމަށް ހުރަހެއް ކަމަކީ ރަށުގެ ޝޯރޫއައިން އާއި ރަށުގެ ފެން ތަޙައްމަލު ބޮޑު ކުރުމަށް ކުރުވާ ޒިރާޢަތުގެ މަސައްކަތްތަކަށެވެ. މި ޒިރާޢަތުގެ ކުރިއަށް އޮތްތަނުގައި ކުރިއެރުމެއް އަދި ތަރައްޤީކުރުމުގައި ފައިދާ ކުރެވޭނެ އަސަރު ކުޑަކުރުމަށް ތަފާތުވެފައި ހުރި ކަންކަން ކުރުމަށް އެކިއެކި ގޮތްގޮތުން ފައިދާވާނެއެވެ. އަދި މިކަމުގައި ފައިސާ ހަރަދުކުރާނެ ކަމުގެ ޙަޤީޤަތްތަކެއް ވަނީ ދެއްކިފައެވެ.

11. ޖުމްލަ ގޮތެއްގައި ދަނޑުވެރި ދަނދޫގައި ތަރައްޤީ މިކުރާ އެގްރިކަލްޗަރަލް ސެންޓަރާއި ދިވެހިބޭސްވެރިކަމުގެ ކޮލިޖަކާ ހިންގުމުގައި މިމާލޭއޮބަން ކުރާނީ ކުޑަމިންވަރަކުން ނަރުދާ އަސަރުއެޅޭކަމުގައެވެ. މިކަމުގެ ސަބަބުން އޮފީސަރުން ދުވި ރައްޔިތުން ދިރިއުޅުމާއި އަދި ދިވެހިސަރުކާރާއި ގޮތުން ދިރިއުޅެމުންދާ ފައިދާ ތަފާތު އިޤްތިޞާދީ ހަރަކާތް، ތަރައްޤީވެރިކަމުގައި ބޭނުންކުރެވޭނެ ރަށުގެ މާހައުލާ ވ ޒިންދަގީއާއި އިޖުތިމާޢީ ތަރައްޤީ މުހިންމު މަސައްކަތް ޖާގަ ފަރުނީޗަރު ފައިދާ ކުރާނެއެވެ. ރަށުގެ މަސައްކަތް ފުރި ކުރެވޭ މަސައްކަތް ހިނގައިގަތުމުން ރަށުގެ ވެރި ގުދުރަތީ ބެލެނުންތަކެއް ކަމަށް އަންނާނެއެވެ. ހަމައެކަނި އުދަރާތު ސަރުކާރުގެ ވަޒީފާތަކުގެ ކަމެއް ކަމުގައި ބެލެވޭ އިރުމަތީފަރާތުން ރަށް ދިރުމުގެ މައްސަލައެވެ. މިފަދަ ފުރުޞަތު ހިފުމަށް ކުރިއަށް ކަމަކީ މާލިޔަތުން މަސައްކަތުގެ ނަތީޖާއިން ކާމިޔާބު ކުރަނީ ކަމަށް ކަމުގައި ބެލެވޭނެ ކަމަށް ފާހަގަކުރެވިފައިވާނެއެވެ.

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2 NON TECHNICAL SUMMARY

1. Baa Atoll Hanifaru was leased in 2008 to Mr. Mohamed Shareef of Maafannu Sunny Coast to develop agricultural activities. Following Environmental Regulation, an EIA Screening Form was submitted to EPA during early 2009. However, after elapse of some considerable period, the erstwhile Ministry of Housing and Environment declared Hanifaru Bay (lagoon) as a protected site under environmental law. Later Hanifaru was also declared as a protected site. In order compensate for this unexpected 'taking away' of Hanifaru, the Ministry of Fisheries and Agriculture, in consultation with Mr. Mohamed Shareef, arranged an alternative island – Baa Dhandhoo.
2. The proposal under consideration is to develop Baa Atoll Dhandhoo as an agricultural island along with three other minor functions. The primary business model is based on production of high quality agricultural products. The island would also be a facility providing complementary and alternative medicine (CAM) services. To complement this function a small nursery of about 4,000 sq feet is proposed to grow indigenous medicinal plants that are becoming rare/extinct. Finally a small visitor centre is proposed which would allow visitors to learn about the activities on the island.
3. Two main approaches – the AutoPot and hydroponics systems – are proposed for the production of rock-melon, cucumber, capsicum, chillies, lettuce, tomatoes etc. The growth system is completely contained either in the grow pots or in water medium. The main development feature of the island is 6 x 4,000 sq feet green houses to set up the AutoPot and hydroponics system. The green houses will be imported and assembled at site. Similarly the AutoPot system will be imported and assembled at site. The hydroponics system will be constructed locally from the imported material.
4. Construction of the buildings will be kept to a minimum; staff accommodation, kitchen / dining facilities will be constructed to accommodate no more than 15 people for the agricultural works. Treatment rooms for CAM treatments will be built on the northern side of the island. A small stilt-jetty is constructed on the western side of the island. A complete list of the buildings is given in the layout plan.
5. The island would be self-contained, and so water production and power generation will take place on the island. An RO plant of 10 cubic meters / day capacity is proposed with intake from the lagoon. To supplement the water production rainwater will be harvested from every possible roof on the island. A 25kW diesel power generator will installed for producing electricity. Storage of diesel on the island will be minimal transporting the required amounts from the nearby islands.
6. The baseline environmental conditions were assessed using standard methods. Significant erosion was observed on the north-western and northern side of the island while accretion was evident on the western side. There appears to be a directional shift of the island to west. However, observation of such magnitude of movement has entirely due to seasonal erosion and accretions have been observed in some islands of Baa Atoll. No interventions for mitigating erosion were proposed at this stage. Bi-annual monitoring of shoreline was proposed to determine the seasonal dynamics of the island beach. No hard structures are proposed at this stage.
7. A Leopold Matrix was used to determine the scale and extent of the impacts. The short-term environmental impact from this development project would to the island

ecosystem from clearance of vegetation. About 60-80 palms may have to remove and/or relocated for the development work that will be replaced accordingly. Loss of top-soil, and shade and the clearance may affect the vegetation around the periphery. It is recommended that clearance take place only where necessary. Septic tanks systems have been proposed for disposing human waste and pose no long-term negative environmental impact considering the small number of people expected to be based on the island. It is recommended that non-biodegradables should be regularly removed from the island for disposal in to another island with arrangement made with the Council. Biodegradable waste from the plant material will be left to appropriately degrade on the island, thereby contributing nutrients pool of the island ecosystem.

8. The Atoll Council and the resorts were consulted regarding the project and their views were considered. There was full support of the Council and no issues were highlighted. There were also no issues raised from the resorts except they wished see only minimal landscape
9. Impacts during the operation phase are considered to be negligible. Overall the impact from the Project will be positive – demonstration of effective economic and sustainable use of uninhabited small islands inducing encouragement for climate-smart type agriculture.

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3 INTRODUCTION

3.1 BACKGROUND AND CONTEXT

The uninhabited island of Hanifaru in Baa Atoll used to be leased on varuvaa to Mr. Mohamed Shareef, of M. Sunny Coast. Varuvaa constitute a nominal amount and the condition associated with it is to simply to 'look after' the island, which otherwise left unattended would fall to abuse and plunder by the public.

Generally there is little one can do on these islands other than natural harvests of coconuts and/or firewood. If one is lucky the island may be a turtle-nesting site and so eggs may be harvested[1]. Rarely the lease holders would undertake agricultural activities, but the understanding between the government and leaseholder is at any point in time the government requires the island it has to be relinquished and nothing may be claimed for compensation or otherwise.

Hanifaru reef has unique and extraordinary natural feature where on the western side, the reef forms a wedge acting as a funnel trapping the incoming productive waters from outside the atoll. The upshot of this concentrated primary productivity is aggregation of unusually large number manta rays and whale sharks nothing like seen elsewhere in the Maldives. The phenomenon is well known among the people in Baa Atoll for a long time, but only recognized and popularized recently, thanks to the tourist resorts and their divers and the Liveaboard Association.

During the 2008 Mr. Shareef submitted a proposal to develop the island for commercial agriculture. As such the commercial lease was determined by the Ministry of Fisheries and Agriculture based on the standard commercial rate at the time. However, any development on the island shall only take place following environmental approvals from the Ministry of Environment based on successful evaluation of an environmental impact assessment report of the project.

The EIA Scoping Form for an agricultural development project was submitted to EPA in early 2009. A decision for the EIA scoping was never made by the EPA. Instead the erstwhile Ministry of Housing and Environment declared Hanifaru Bay as a protected site. Later on the basis of public support, in particular the tourism sector, the Hanifaru Island was also declared a protected site and the Mr. Mohamed Shareef was informed by the Ministry of Fisheries and Agriculture informed that Hanifaru is no longer is available for development.

In order compensate for this unexpected ‘taking away’ of Hanifaru, the Ministry of Fisheries and Agriculture arranged an alternative island – Baa Dhandhoo instead of Hanifaru Island. This development proposal is for Baa Dhandhoo to develop an agricultural project by the proponent Mr. Mohamed Shareef of M. Sunny Coast.

[1]Harvesting of turtle eggs are banned from 2008 under the current Moratorium.

3.2 PROJECT SETTING & JUSTIFICATION

The proposal is to develop Baa Atoll Dhandhoo as an agricultural island where climate-smart type agriculture approaches will be used to produce high quality products. This main agricultural activity is linked to achieve three other minor objectives;

1. Develop Dhandhoo as a demonstration site for climate-smart type agriculture (use of AutoPot and Hydroponics systems).
2. To establish a small medical clinic to provide services of complementary and alternative medicine (CAM) under the auspices of reputable local CAM specialist
3. To establish a 4,000 square feet nursery for indigenous medicinal plants of value and that are becoming rare in the Maldives.

The project site –Dhandhoo island– on the north east of Baa Atoll, is not far from Fonimagoodhoo Island (Reethi Beach Resort) (Figure 1). A moderately developed reef, Vandhoomaafaru Reef on the atoll rim shelters Dhandhoo form the oceanic swells. Inhabited island Kamadhoo is in the north and Dharavandhoo is in the south 6.5 and 10km respectively. Several resorts lay close by; Horubadhoo, Kihaadhupparu, Reethi Beach, Landaagiraavaru and the recently opened Kihaavah-huravalhi resort all lie within 10-15 km from Dhandhoo Island.

Figure 1: Location of Dhandhoo (circled red) in Baa Atoll.

Agriculture sector is one of the fastest growing primary sectors. The most common produce in the Maldives (not in any order of importance) are watermelon, cucumber, lettuce, cabbage, chilly, papaya, pumpkin, banana and Romain lettuce. Some of these, for instance, cucumber and lettuce are also produced in hydroponics systems.

The Ministry of Fisheries and Agriculture reports a large volume of production from the islands is brought to capital Malé for sale in the local Market or supply to the high-end outlets. The latter are from reputed producers who have invested in agriculture business on islands rented for long term. Recorded quantities of these products brought to Malé Market has been steadily increased and so as the declared of their sale (Figure 2). Despite the large volume of the produce lack of standards, quality and irregular supplies makes difficult to market the general produce to resort market. This issue has been reported in the draft of the current Tourism Master Plan[2]

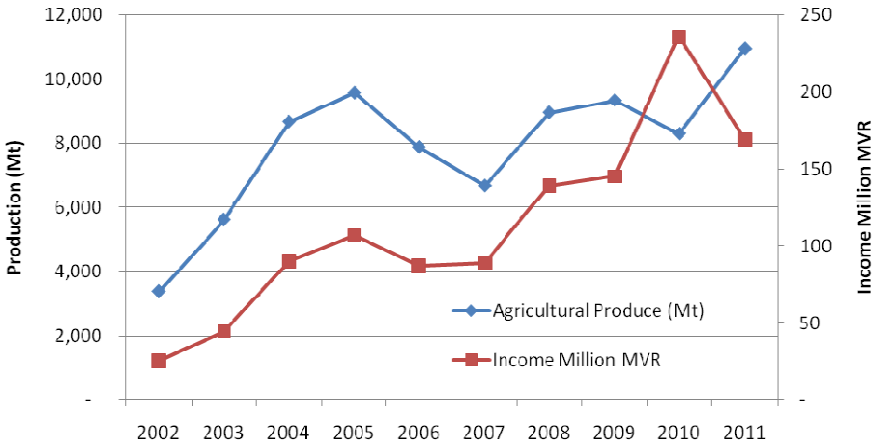


Figure 2: Recorded total agricultural production and its declared value at Malé Market (source: MoFA)

In order to establish greater backward linkages with agriculture the government is giving incentives to local growers in the island and in some cases indirect subsidies to help them realize the value in their produce. There is no doubt that there will be greater benefit from better integration of the agriculture sector into the existing tourism value chain.

Like several other small island nations, development in the Maldives is also constrained by the absence of land based mineral resources, the limited scope for expansion of the agriculture sector, and vulnerability to natural disasters and environmental hazards. Therefore preferred approach would be to develop climate smart-type agriculture.

The economic feasibility of the type of agricultural method proposed has been recently studied by the UNDP. The report reviewed the AutoPot farming operations in 4 islands following the pilot phase undertaken in Sh. Atoll (Kendhikolhudhoo) in 2008. The report suggests healthy returns with payback period of only 3 ½ years for small-medium size investments[i].

3.3 EIA REPORT

In general the objective of an EIA report is to address the environmental concerns of the development project. The EIA will help to achieve efficient planning, aid in identifying impacts and their mitigation measures if required during development and it in the

[2] http://www.tourism.gov.mv/article.php?aId=1059, accessed March 2013.

operational phase. The EIA report will also help to promote informed environmental and sound decision making during the development of the project.

The development takes place in area declared as biosphere reserve – the only such area in the Maldives. As such the EIA report provides a legal protection for the proposed development.

3.4 METHODOLOGY

The EIA process followed in the Maldives has evolved to an internationally recognized standard. Started around 1995/1996 the EIA Regulations underwent a major revision in 2007. The EIA Regulation[3]stipulates the complete process including EIA screening, scoping, review, public comment, followed by issuing of decision notes. In order to maintain the standards EIA reports are peer-reviewed and the consultants are registered.

The process is shown in Figure 3. What has been lacking in the Maldives is strategic environment assessment, which gives directions for environmental management, including spatial planning and development strategy.

As shown in the flow chart, the actual process of the methodology in preparing the EIA follows the screening where a decision is made whether the project requires an EIA or not. Under the EIA Regulation, agriculture development projects require EIA and so the screening lead to scoping meeting held at EPA. Key stakeholders attended the meeting, among them were officials from the Ministry of Fisheries and Agriculture and representative from the Baa Atoll Council.

The developmental activities identified in the project are simple and interventions were expected to have minimal or negligible environment. Impacts are identified using a Leopold Matrix where the impacts are qualitatively scored based on past experience of previous projects and expert judgement.

[3]Environment Impact Assessment Regulations, 2007.Ministry of Environment, Energy and Water, Malé, Maldives, 74 pages.

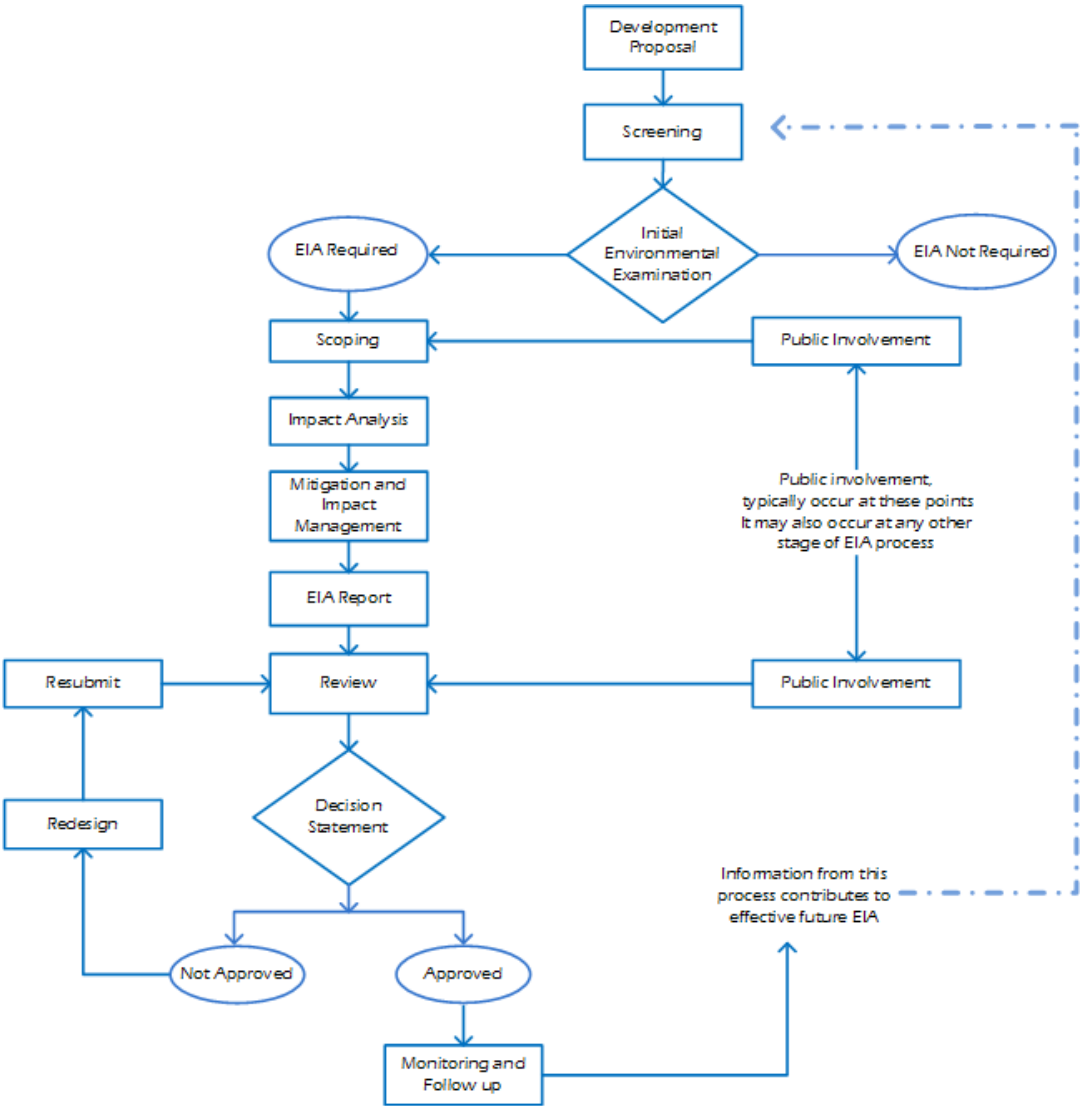


Figure 3: A general flow-chart of the EIA process that is followed in the Maldives.

4 DESCRIPTION OF THE PROJECT

The proposal is to develop Baa Atoll Dhandhoo as an agricultural island with the objective of demonstrating the economic value of small-scale climate-smart type agriculture linked to tourism sector. The development also involves a small clinic to provide services of complementary and alternative medicine (CAM) along with the small nursery for indigenous and rare medicinal plants.

The development aspects of the project can be summarised as follows:

a) The main commercial objective of the Project is growing high quality fruits and vegetables using climate-smart type agriculture. The south central section island will be devoted for this activity. Six green houses have been proposed each with an area of about 4,000 sq feet. Four green houses have been proposed with the plans for extending up to 6. The green houses are to be imported from overseas and will be assembled at site. It is proposed to grow cucumber, lettuce, tomato, rock-melon and chilly using AutoPot and hydroponics systems. The main market would be the resorts and exclusive retail outlets in Malé

b) The developer of the island is associated with famous local CAM practitioner who has excellent track record of treating ailments of elderly people ranging from gout to respiratory to skin problems. He is also famous for his own creation of medication and CAM drugs concoctions. He has been a member of the National Committee of CAM which has been not too active. Presently retired, he is keen to teach younger and interested groups on CAM he has mastered over the years. The way the service is planned is that people requiring the service will visit the island and stay for the duration of the treatment. In this sense the island will be act as a small sanatorium.

c) A third, but minor objective is development of small nursery for indigenous medicinal plants which are becoming rare in the Maldives. Such a nursery is now absolutely required. The last know such nursery was at Dharubaaruge courtyard in Malé[ii]. The trees in the entire area were extirpated for the purpose of developing a five-star hotel proposed by Shangri-La during Gayyoom Administration. Unfortunately the project proposed by the Malé Investments Pvt. Ltd never got materialized at the last stages arising complications in the allocated land. This proposal here at Dhandhoo would be to have small nursery where selective medicinal plants will be grown. Some will be sold but it is expected young trees will be given away.

Infrastructure development for these activities involved standard buildings. The tentative layout plan shows 10 building (~ 1,000 sq feet each). A small stilt-jetty is proposed on the western side where reef edge only about 15-20m from the beach. On the northern side, 4 treatment rooms have been proposed on the lagoon. The rooms are on stilts but very close to the beach. The layout plan is given in Annex 2

The island will be fully self-contained and as such water production and generation of electricity is proposed. It is expected no more than 20 people will be permanently stationed on the island. With the patients and visitors and it is expected that no more than 35 people will be on the island at any given time.

Based on details of the project, impact prediction and analysis shows the negative environmental impacts minimal and positive socio-economic impacts outweigh the short/ immediate term negative impacts.

4.1 AGRICULTURE PRODUCTIONS

4.1.1 Hydroponics Systems

Hydroponics is a subset of hydroculture and is a method of growing plants using mineral nutrient solutions, in water, without soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, mineral wool, expanded clay or coconut husk.

Researchers discovered in the 18th century that plants absorb essential mineral nutrients as inorganic ions in water. In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. Almost any terrestrial plant will grow with hydroponics. Hydroponics is also a standard technique in biology research and teaching

Figure 4: A hydroponics system growing lettuce. Water medium supplemented by ‘growth solution’ circulates in the pipe system.

4.1.2 AutoPot System

The AutPot is an automatic watering system. At the heart of the system is the AquaValve which regulates availability of a ‘water cycle’ mimicking the wet and dry conditions. The water is fed by gravity and no electricity is required. Once connected the AquaValve will open and allow water to fill the tray to a preset level. The AquaValve will not fill the tray until the all the water has been used allowing the plant to go through a period of dry and wet cycle. Once the all the water has been used by the plants the AquaValve will re-open and refill the tray repeating the cycle.

Various ‘growth factor’ solutions are added and mixed with water in gravity tank to accelerate growth. The set up can be scaled up to 1,500 to 2,500 pots to full commercial levels.

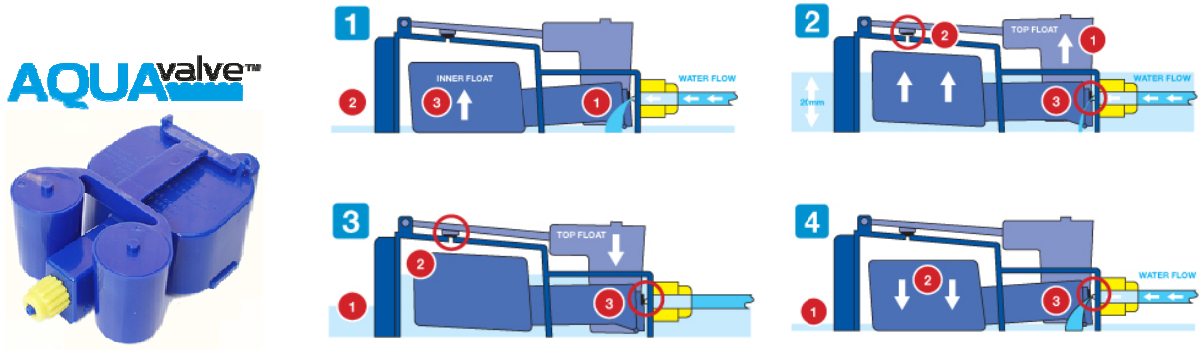


Figure 5: The AquaValve used AutoPot system is designed to deliver water at periodic interval through a simple mechanism operated by a combination air pressure created by water and gravity. (see :http://www.AutoPot-usa.com/aquavalve.html, accessed January 2013).

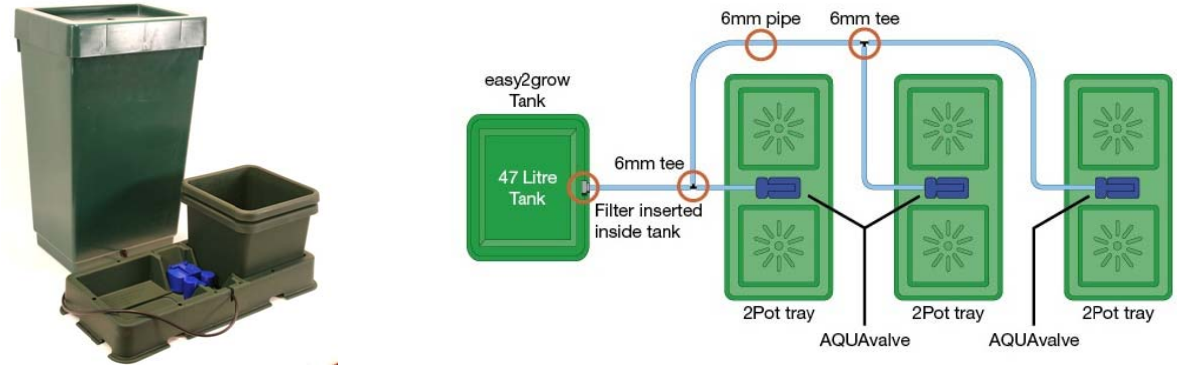


Figure 6: The AutPot system can be extended in series to several grow pots. The company provides information for most effective arrangement and size of water-butt. See Annex 7.

Figure 7: Images from AutoPot System Catalogue. In the most recent catalogue, they report a system that uses 1,500 pots to grow chillies, cucumbers, and tomatoes to supply Hilton Resort in the Maldives.

4.2 DEVELOPMENT OF THE CAM FACILITY

The facility to be developed for complementary and alternative medicine (CAM) will involve reception facility, and the treatment rooms. It is expected the ingredients will eventually be sourced entirely from the island (see Section 4.3: Nursery for Indigenous Medicinal Plants).

The proponent does not expect this to be a major economic activity. At the start only few may be interested in the service. Traditionally the CAM treatments take place at their own homes with the families. The idea of the travelling to a small island for treatment may at first be odd. The expected clientele would be high-income bracket individuals who wish to try an alternative approach to their ailments.

Figure 8: Sample of ingredients for Complementary and Alternative Medicine (CAM). Only indigenous medicinal plants will be used for CAM. (images for sample only)

4.3 NURSERY OF INDIGENOUS MEDICINAL PLANTS

A nursery of about 4,000 square feet will be developed for growing medicinal plants that are now becoming rare and difficult to get in the Maldives. Depending on the popularity of the CAM facility the harvests will be used for local consumption for CAM activities.

Figure 9: A small nursery for indigenous medicinal plants will be created. Priority is for plants are that now becoming rare and difficult to obtain. Image – sample only.

However, it is also expected that other practitioners may wish to source material the plant or the processed products from the island. In this case it will be sold for public. Advertising and PR is planned once the facility becomes operational.

4.4 DEVELOPMETS OF THE ISLAND

4.4.1 Infrastructure Developments

The proposed infrastructure developments are follows:

1. Stilt Jetty / Jetty head on the western side (up to the reef edge).
2. Green House 6 x 4,000 sq feet
3. A small laboratory for onsite chemical tests
4. Storage area for harvest crops / cold rooms for vegetable storage
5. Fertilizer / chemical storage room
6. Reception facilities for visitors
7. Staff accommodation / kitchen / mess room
8. Senior staff accommodation
9. Power house / RO Plant
10. Fuel / water tank / Rain water tanks
11. Mosque
12. CAM treatment rooms on the north of the island.

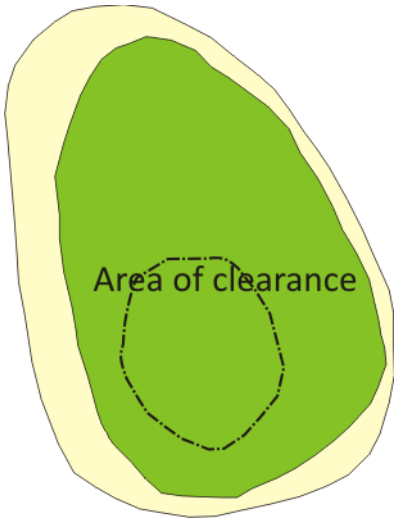


Figure 10: Schematic figure to show the main area of clearance on Dhandhoo for the development work.

The proposed developments will take place on the southern section of the island. Surveys showed the area has a lower density of vegetation. According to the proponent this area was used for agricultural purposes earlier. As indicated in section 6.5.3 (Vegetation Cover), the area has number of palms fronds (pinnae) have fallen of. It is believed that these might have been palms where toddy tapping has occured.

4.4.2 Power Generation and Water Production

Power generator will be installed early in the development. It is estimated that no more than 25kW will be required even at full operation of the facility. A soundproof, compact diesel power generation unit will be installed as indicated in the plan. Transmission cables will be buried with appropriate protective covering. Mindful of reduction fossil fuel burnt, lead light will be used as much as possible. Lead lights although expensive are known to last much long and consume only a fraction of the regular incandescent bulb.

A small diesel storage tank (about 1,000 litres) will be installed. Tank will placed insider bunded area to avoid any spill leaking into the ground.

Ground water will not be extracted at any stage. Therefore an RO plant will be installed and commissioned at very early stages of the development works. A 10,000 litre capacity RO plant will be installed. It is proposed that intake will be placed in the southern side and outlet on the western side. The effect of discharge of brine is unlikely to have a visible impact to the environment. The effects if any would be immediately diluted to insignificant levels by the currents. Storage tanks of 2 x 1,000 litres will be installed. RO product water and rain water will be mixed and stored. RO production will only be done when required. Rain water will be harvested from every possible roof available and connected to the storage tanks. Care will be taken for safer harvest and storage of rain water.

4.4.3 Waste Management

On a small island such as Dhandhoo waste management is important to avoid negative environmental impact on the ecosystem. Presently tin cans and plastic bottles litter the periphery of the island, especially on two sites where picnics are entertained. Such accumulation of the solid waste would compromise the integrity of the island ecosystem. Such littering should not be tolerated at any stage during development and operational phase of the island.

Non-degradable waste will be collected in appropriate collection areas and taken to the waste management sites of the atoll under arrangements with the Councils.

Sewage will be disposed via septic tank system. Many inhabited islands in the Maldives still use this system. With proper design the method is safe and can avoid contaminating ground water. For only 15 – 20 people on Dhandhoo the septic tank system is considered to be effective and safe.

In the septic tank system sewage and waste come into septic tank and solid matters settle down at the bottom of the tank. Anaerobic Bacteria convert the sewage into liquid and gases during the process of digestion. In this way there is appreciable reduction in the volume of waste and it changes into semi solid condition, which is called sludge. It is necessary that septic tank is covered with water tight top roof slab. Following general guideline lines should be used for the use of septic tank system.

1. Sufficient water is required for proper functioning of septic tank.
2. The waste containing detergent should be avoided in septic tank as it had adverse effect on anaerobic bacteria.

3. Septic tank should have minimum width of 0.75 meter and minimum depth of 1 meter below water level of the septic tank.
4. Length of the tank should be 2 to 4 times the width.
5. Every septic tank should be provided with ventilation pipe of at least 50 mm diameter.
6. Minimum free board above water level should be of 30 cm.
7. The floor of the tank should be of cement concrete 1:1.5:3 and has a minimum slope 1 in 10 provided towards the sludge outlet to facilitate de-sludging.
8. The inner surface of septic tank should be plastered with rich cement.
9. For efficient working of septic tank the sludge should be cleaned half yearly or yearly

Plant Waste: A major waste, although biodegradable, would be the plant waste from the harvests. Once harvested for several seasons the plant needs to be replaced with new seedlings. Such removal may create waste which most of it will be left decomposed in selected area. Any plant material deemed removal will be disposed with the non-biodegradable waste.

4.5 DEVELOPMENT SCHEDULE

An indicative development schedule is given in Figure 11. Construction of medicinal plant nursery and the CAM treatment rooms will be done later in the development phase. It is expected the project will be fully complete by March 2014.

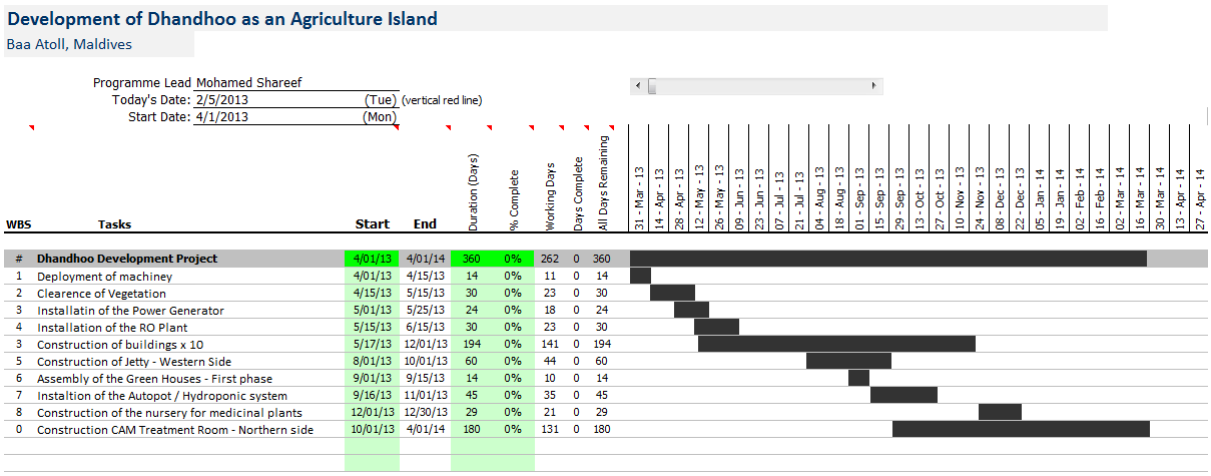


Figure 11: Indicative schedule of the work and its current progress.

4.6 PROJECT INPUTS AND OUTPUTS

The input / output analyses of a project helps to define and understand potential environmental impacts of the project in an informed way. Linking inputs to processes and activities leads to outputs and consequently impacts – positive or negative. The inputs and outputs relating to the development of Dhandhoo Island may be derived from the project concept and the project description and site plan of the Island.

For the development works following material will be imported.

1. Construction workers and labourers: A large proportion of construction workers in Maldives are expatriate labourers imported from countries within the region. Various socio economic issues resulting labour importation issue is now public knowledge. Due to small scale of the project it is expected the development will NOT require additional labour import quota.
2. Construction materials: These include river sand and aggregate, concrete, timber and timber products, metal and aluminium products, plastics, gypsum boards and plywood, fibreglass materials, paints, varnish, thinners and hydrocarbons, ceramic tiles, electrical wires and many types of industrial cables, glass and plastic sheets. The isolated nature of the island requires that all such construction material be transported to the site by sea and stored on the island itself.
3. Construction tools and machinery: small vehicles and construction machinery, excavators, lorries, concrete machines, and tools.
4. Power generation: 25 kW Diesel generator and cables and appliances
5. Water production: About 10 cubic meters per day RO desalination plant and piping
6. Diesel and other heavy oils and lubricants for power generation and operation of all types construction and other machinery
7. Office equipment: Televisions, Computers, fax and copying machines, telephones and accessories, air conditioning equipment.
8. Kitchen appliances and tools: Refrigerators, ovens, microwaves and cooling equipment
9. Transport: Speed boats and power motors use highly inflammable fuels such as petrol and kerosene. Slow boats such as *dhonis* use diesel and other fuels.

The Outputs of the Dhandhoo development project can be summarised as below:

1. Cleared vegetation and possibly some trees. Many of these will end up in waste disposal sites in Baa Atoll.
2. Construction wastes including leftover concrete
3. Organic wastes such as plant materials resulting from land clearings
4. Burnt fuel emissions and left over oil wastes and bilges
5. Food and kitchen / wastes

4.6.1 Accidents and hazards

Hazards and likely incidents that will compromise the environment are negligible, both during the construction and operational phase of the project. Health and safety issues relating to handling plant material and growth solution and or fertilizers will be regularly briefed to staff. Necessary instruction and warning signs will be posted in the work areas where appropriate.

5 REGULATORY CONSIDERATIONS

There are very few regulations pertaining to development and works relating to islands leased for agricultural developments. The lease agreement between the proponent and the Ministry of Fisheries and Agriculture draw the boundaries regarding 'use' of the island. The Law No. 20/98 relating to the uninhabited islands will technically become void once the island is leased for commercial purposes.

There are regulation on importing plants and animals into the Maldives. Any seed or seedling that need to be imported for the Project will have to be quarantined by the Animal and Plant Quarantine Unit of the Ministry of Fisheries and Agriculture in Hulhule. The practice is that importation should accompany a quarantine certificate from the state facility along with prior permission from the Ministry of Fisheries and Agriculture. Importation that violates these rules are confiscated and destroyed at the Plant and Animal Quarantine Unit.

Regulation on utting down, uprooting, digging out and export of trees and palms from one island to another will be applicable. The preamble of this regulation states the purpose of the regulation is to educate citizens and developers about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the regulation certain tree are prohibited to remove from island. They include:

1. The coastal vegetation growing around the islands extending to about 15m into the island
2. All trees and palms growing in mangroves and wetlands spreading to 15m of land area
3. All trees in Government protected areas
4. Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
5. Trees / palms those are unusual in nature.

The regulation states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances an EIA and Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more 15feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (i.e., Atoll / Island Councils).

6 EXISTING ENVIRONMENTAL CONDITIONS

A series of rapid survey techniques were used to assess the beach, terrestrial and marine environment. These techniques are consistent methods and procedures recommended by the EPA.

Main objectives of the assessment were:

1. To determine the type and density of flora present on Dhandhoo Island
2. To determine the general soil characteristics.
3. To determine the quality of groundwater
4. To obtain beach high/low tide, and beach lines and beach profiles on Dhandhoo
5. To establish the conditions of Dhandhoo reef.

6.1 METHODOLOGIES

Terrestrial flora Surveys: Like in most island, the dominant and most prominent vegetation is the coconut palms (*Cocos nucifera*). Even though the island was small, total enumeration was proved to be difficult. Transect counts also proved difficult due to dense vegetation cover. Instead a rapid visual assessment was undertaken. Using a GPRS-enabled GPS twelve, relatively, random positions were chose that allowed counting of coconut palms in the visual field. Only mature palms (about 3-5 m high) that were visible above the canopy were counted. Aside from assuming the choice of counting location were random, it was also assumed that visual field had radius of no more than 15m. This was judged by estimating the distance of the furthest palm counted in individual visual fields.

Data provided the mean palm count for unit area and by knowing the total vegetation cover, estimate of the palms on the island can be made.

For the other species the DAFOR scale[iii] was used. DAFOR (Dominant, Abundant, Frequent, Occasional and Rare) is often a method of defining abundance, especially where quick surveys are being used, or the precise numbers or coverage of a species in the field is difficult to measure. The method is open to interpretation, and is therefore only a broad estimate of frequency. Attempts are sometimes made to standardise the meaning of the terminology; also qualifiers (e.g. l-F – locally frequent) may be employed.

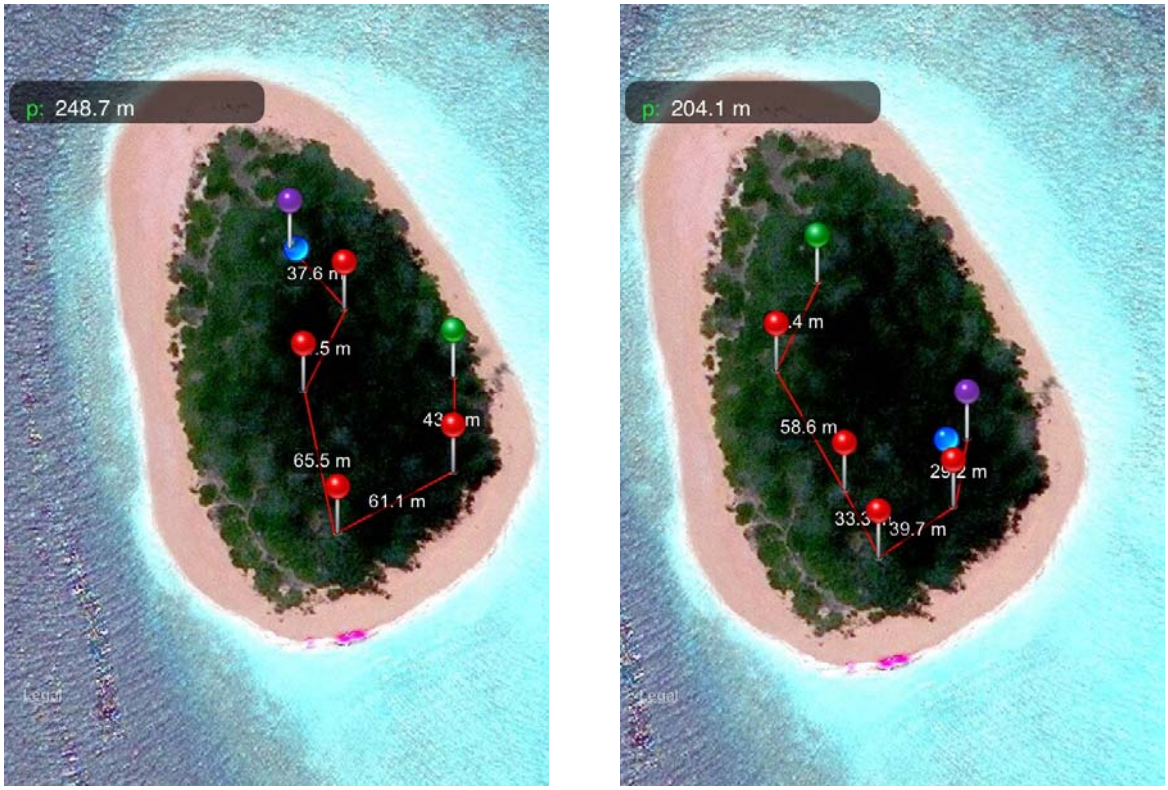


Figure 12: Randomly selected 12 positions where visual counts of coconut palms were made. These positions were made on an Apple iPhone using Measure Map Application which places a pin on the position.

Groundwater Assessments: A single randomly chosen location was decided to dig a small well. Once the water is settled (after about 2 hours) water samples were collected in clean 1.5 L PET bottles after washing them with water to be sampled. Parameters tested for ground water quality assessments were physical appearance, temperature, pH, electrical conductivity, total suspended solids, Biological Oxygen Demand. All parameters were analyzed at the Maldives Water and Sewerage Company laboratory.

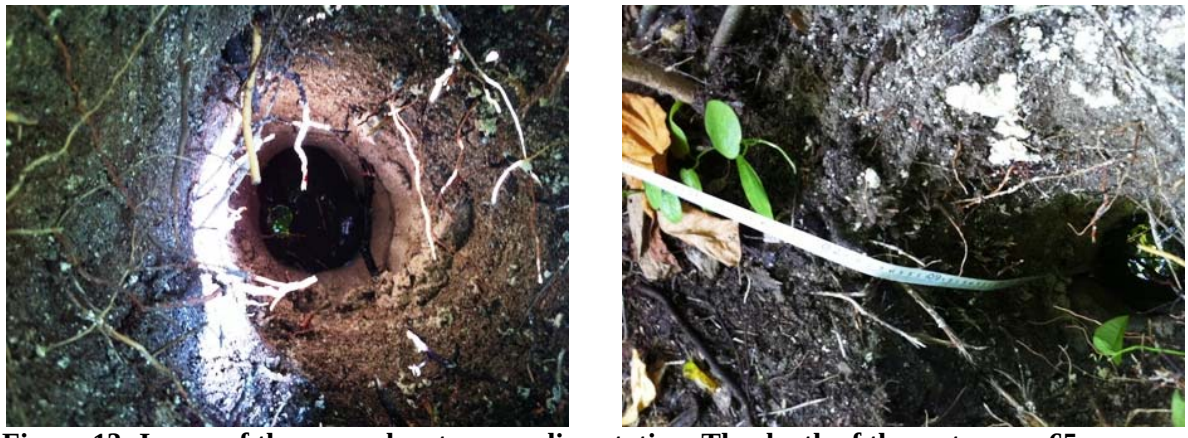


Figure 13: Image of the ground water sampling station. The depth of the water was 65 cm.

Marine Environment Assessment: Normally in an EIA one wants to understand the general condition of the reef, giving qualitative description of the substrate conditions and relative differences between the different sites observed during the survey. Many consultants provide photographic images and provide narrative description of the conditions. Following this approach two areas were chosen; on the west and other on the north, where a reef length of about 50 m 100 m respectively was observed.

At each site, series of high density photographic images were taken in sequence by keeping the camera at horizontal plan. An image was taken at each two-fin kicks until along the reef edge.

Fish Census: Visual assessment of fish fauna was undertaken at each site. They were of standard swims lasting for about 10-15 minutes. Abundance categories of conspicuous species were noted as Rare[R], Abundant[A], Common[C] and Schools[S].

Beach lines: Standard GPS instruments were used to survey beach lines, vegetation line and to estimate the areas.

Beach Profiles: standard equipment was used to obtain the data for beach profiles. Six beach profiles were taken.

6.2 STUDY AREA AND SURVEY LOCATIONS

The study area covers the terrestrial environment of the island is given in Figure 14 below shows the specific study area and survey locations with their respective GPS co-ordinates.

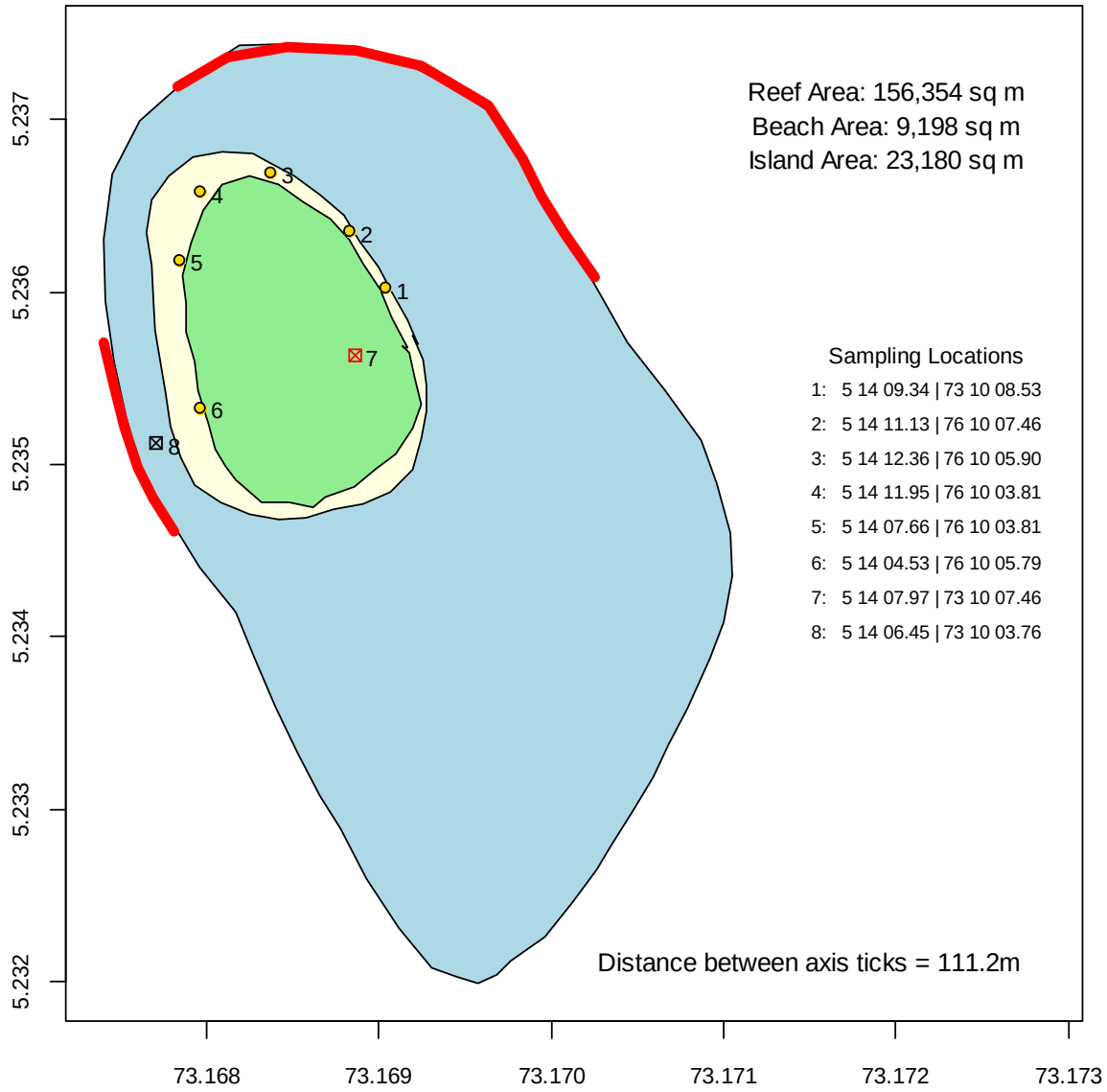


Figure 14: Study area and Survey locations, Sampling Locations 1-6 are position of beach profiles [degree, minutes, seconds in 2 decimal place], 7: ground water sample, 8: lagoon water sample, the coloured line indicates area covered in the reef survey.

6.3 METEOROLOGY AND CLIMATE

Meteorological observations in Maldives are limited to airports. A total of 9 airports are in operation, however observation takes place only on 5 airports (Figure 15). Observation taken include, wind speed and direction, daily minimum and maximum temperature, humidity, cloud cover. Monitoring of sea-level height takes place only in Hulhule and in Gan Island (in south).

It is a fair and a reasonable assumption that average climate conditions do not show much variation between different islands. For the purposes of this EIA observations from the Hulhule will be used to describe the climate condition around the project area. The website

www.weathersparks.com provides average weather condition around Malé International Airport (Hulhulé Island, Maldives) over course of an average year. It is based on the historical records from 1998 to 2012[iv].

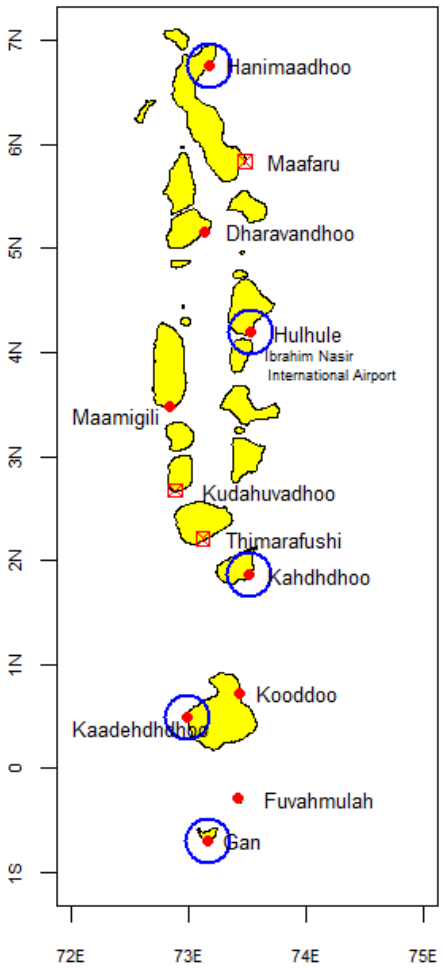


Figure 15: Airports in the Maldives indicating the operating airports (red circle) and proposed ones (crossed square) along with airports that have facilities for meteorological observations.

The climate in Maldives is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 – 85%. The annual average rainfall is approximately 1,950mm[4]. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year. Table 1provides a summary of key meteorological findings for Maldives.

6.3.1 Monsoons

The climate of Maldives is characterised by the monsoons of Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in

[4]National Meteorological Centre, Maldives; http://202.21.178.203/mms/, accessed October 24, 2011

Maldives: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns (Figure 17, Figure 18&Figure 16). The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

Table 1: General Meteorological Information about the Maldives.

Parameter	Data
Average Rainfall	9.1mm/day in May, November 1.1mm/day in February
Maximum Rainfall	184.5 mm/day in October 1994
Average air temperature	30.0 C in November 1973 31.7 C in April
Extreme Air Temperature	34.1 C in April 1973 17.2 C in April 1978
Average wind speed	3.7 m/s in March 5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mb in December 1010 mb in April

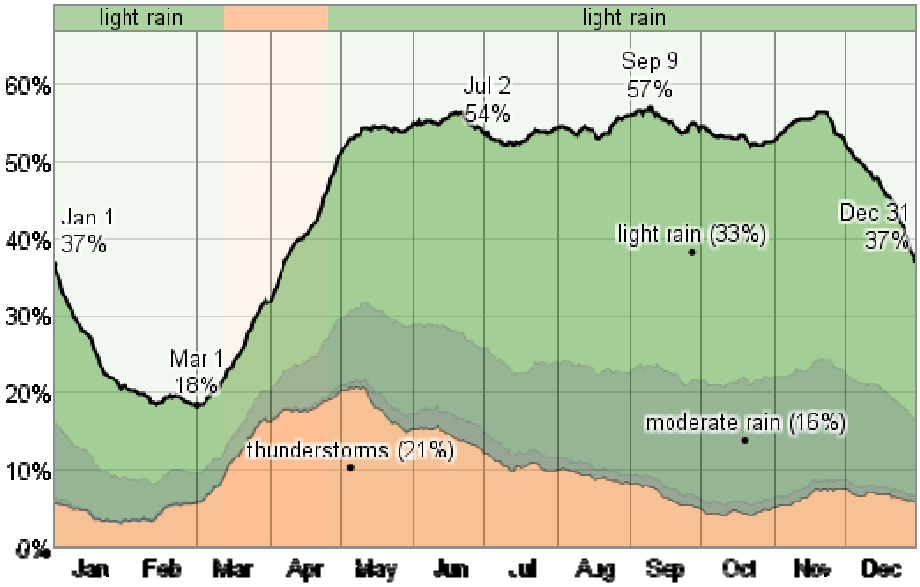


Figure 16: The fraction of days in which various types of precipitation are observed. If more than one type of precipitation is reported in a given day, the more severe precipitation is counted. For example, if light rain is observed in the same day as a thunderstorm, that day counts towards the thunderstorm totals. The order of severity is from the top down in this graph, with the most severe at the bottom. Source: http://weatherspark.com.

6.3.2 Winds

The winds that occur across Maldives are mostly determined by the monsoon seasons. The two monsoons are considered mild given that Maldives is located close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to October (Figure 18). During stormy conditions gusts of up to 60 knots have been recorded at Malé.

Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms^{-1} for the period 1975 to 2001. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003). Annual averages shows that wind directions are mostly in W (32%) and E(11%) and NW(10%) (Figure 17).

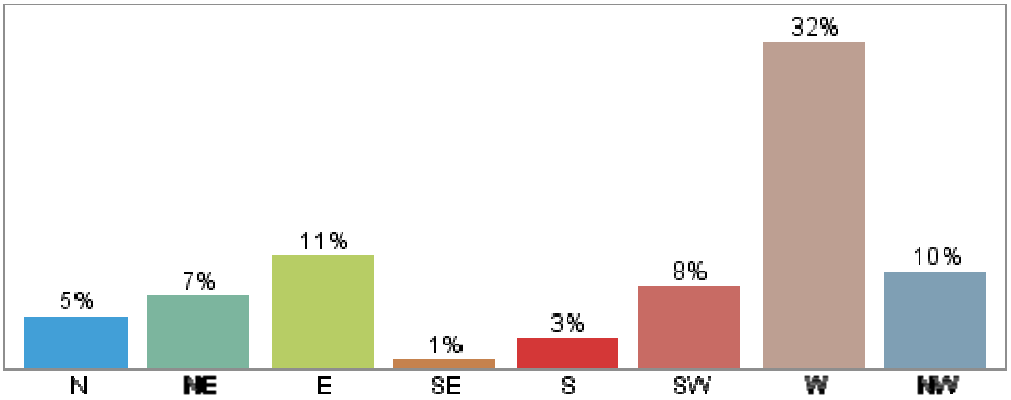


Figure 17: The fraction of time spent with the wind blowing from the various directions over the entire year. Values do not sum to 100% because the wind direction is undefined when the wind speed is zero

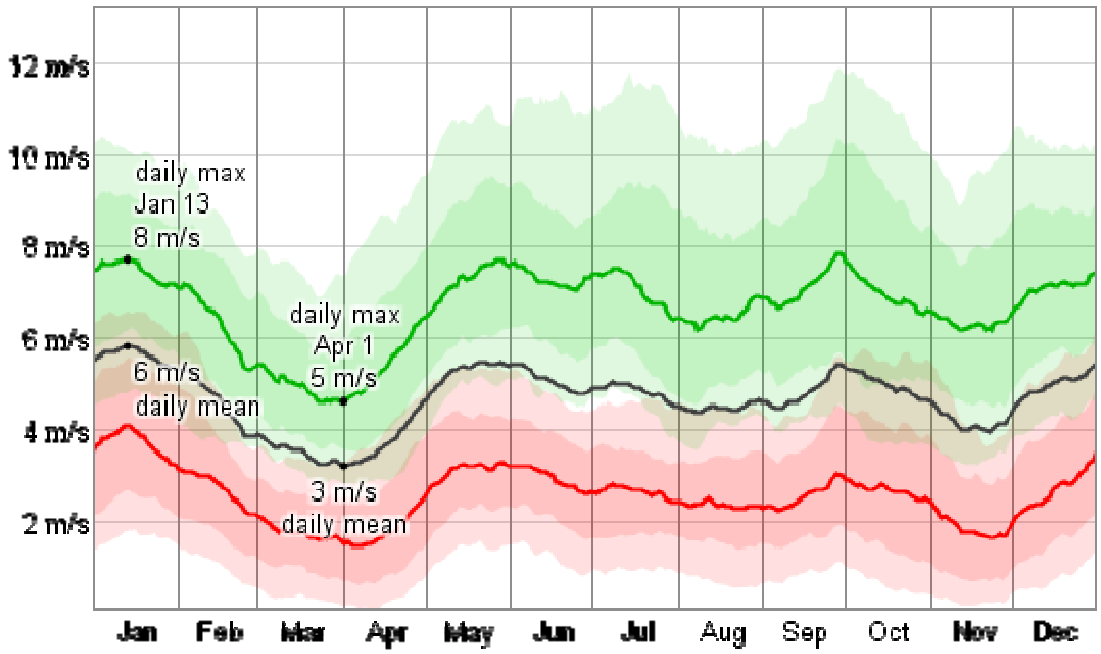


Figure 18: The average daily minimum (red), maximum (green), and average (black) wind speed with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

Table 2: Summary of general wind conditions from Gan Meteorological Center.

Season	Month	Wind
NE - Monsoon	December	Predominantly from NW-NE. High Speeds from W
	January	
	February	
Transition Period 1	March	From all directions. Mainly W. High Speeds from W.
	April	
SW - Monsoon	May	Mainly from W. High Speeds from W.
	June	
	July	
	August	
	September	
Transition Period 2	October	Mainly from W. High Speeds from W
	November	

Temperature: The daily average temperatures rarely drop below 25°C and rarely go above 32°C. Figure 19shows daily average low and high temperatures for Malé area. The warm period of the year is from March to May with an average daily high temperature above 31°C. The hottest day of the year is during April, with an average high of 32°C and low of 28°C.

The cool periods lasts from October/November to January with an average daily high temperature below 30°C. The coldest day of the year is around mid December, with an average low of 26°C and high of 30°C.

Temperature

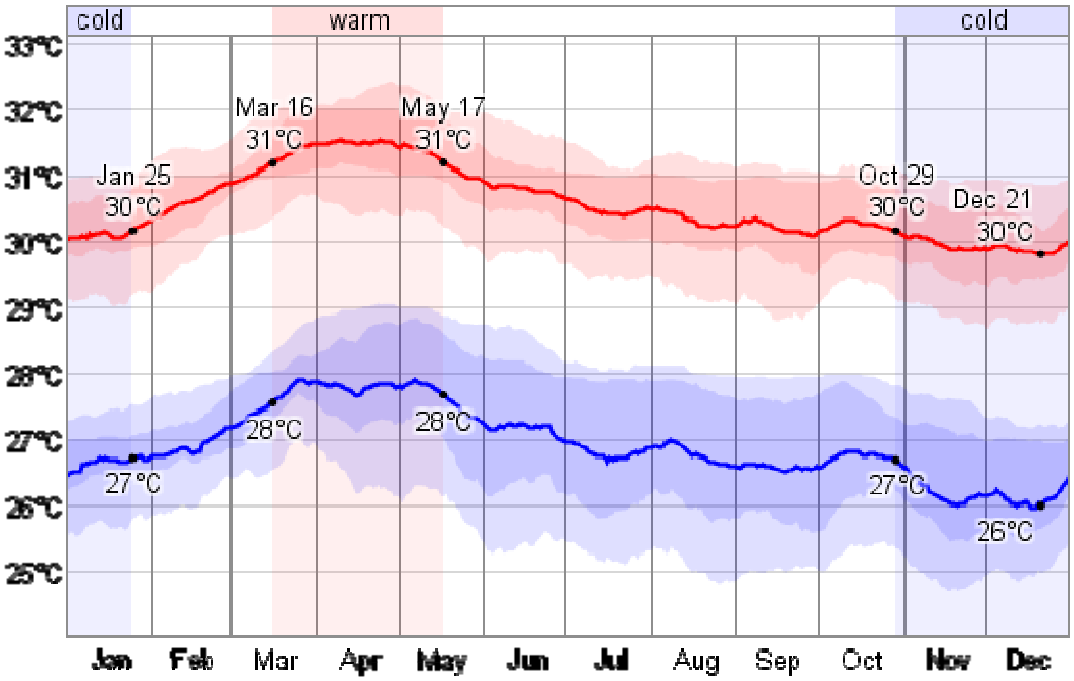


Figure 19: The daily average low (blue) and high (red) temperature with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

6.4 HYDROLOGY

6.4.1 Waves

Two major types of waves are observed along the coast of Maldives. The first is waves generated by local monsoon wind with a period of 3-8 seconds and the second is swells generated by distance storms with a period of 14-20 seconds (DHI, 1999[v]). The local monsoon predominantly generates wind waves which are typically strongest during April-July in the south-west monsoon period.

Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 metres that flooded Malé and Hulhumalé1987 are said to have originated from a low pressure system off west coast of Australia. More recently in May 2007 swell waves that originated from the

southwestern side of the Indian Ocean caused flooding in 35 inhabited islands across 13 atolls.

In 2004 Maldives was subject to earthquake generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003). More recently 2004 tsunami, originated in Ache, Indonesia, cause serious damage, although minor to the southern atolls, including Huvadhoo Atoll.

6.4.2 Tides

Tides experienced in Maldives are mixed and semi-diurnal/diurnal. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively. Maximum spring tidal range in the central and southern atolls is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Like in most other atolls, semidiurnal tides are experienced in Baa Atoll - that is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year. Tidal variations in Maldives are presented in Table 3.

Table 3: Tidal variations at Malé International Airport.

Tide Level	Referred to MSL
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0.00
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MHLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

Astronomical tides are related to the motion of the earth-moon-sun system, and have a range of periodicities. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2m from lowest to the highest tide levels were recorded in the country.

6.4.3 Surface Currents

Currents that affect the reef of Dhandhoo can be caused by tidal currents, wind-induced currents and wave-induced currents. In most the case the reef significantly changes the flow pattern once the waves pass over the reef. During the tidal flow currents can vary between the 0.15 -0.25 m / sec. Flow level of upper range was observed on the reef flat during the tidal flow, northern side of the island. More closer to the beach area on the west and northern side, flow patterns in the lower range was observed.

It should be noted that generalized pattern of currents around the islands cannot be established with short term observations, for the kind EIA work done in the Maldives.

6.5 TERRESTRIAL ENVIRONMENT

6.5.1 Assessment of Soil

The top most layer (~15-20 cm) had black humus soil. The soil was soft and loose due high composition of decaying leaves, roots and plant debris (Figure 20). Following the top layer a coarse sandy layer, mixed with *akiri* pebbles was observed. This was followed by the slightly less, but white medium to coarse sand. There were root of the bushes /trees in the coarse white sand and also some in the bottom layer just before it reached to water level. Water level was estimated at 62cm.

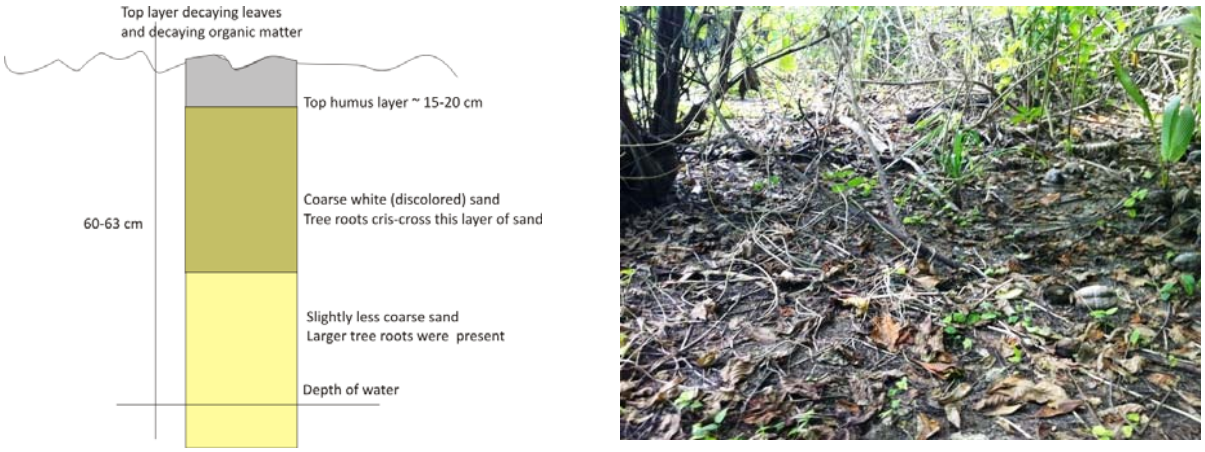


Figure 20: Schematic figure to show the various layers of soil observed in the sample pit(left). Humus laden soil on the top layer is contributed by the vegetation – Dhandhoo January 2013.

6.5.2 Groundwater Assessments

The water table is approximately 62-65 cm below ground level at MSL, and is subject to vary with tidal fluctuations. Table 4below shows the parameters tested and the results.

Table 4: Ground water quality test results.

Parameter	Groundwater, Point #7
Temperature (^{o}C)	28°C
pH	7.49
Salinity	0.79
Electrical Conductivity (µS/cm)	1631
Total Dissolved Solids	816
Total Suspended Solids (mg/L)	273

6.5.3 Vegetation Cover

The dominant form of the vegetation is the coconut palm and so greater effort was made at estimating the abundance of the palms vegetation. As indicated earlier the number of palms in the each of the randomly chosen visual assessment counted and the number of palms in each count was:

```
> cocos
 [1] 17 21 26  6 26 26 13  4 31 22 22 13
```

The mean count was 18.92. Assuming the catchment in the visual assessment field was of 15 m radius (i.e., area of 706 m^2) and given that the area of the vegetated part of the island is 23,180 m^2, then the mean number of the coconut palms on the island would be 620 ± 276 trees. It should be noted counts were done only for palms above the average canopy and so the actual number may be biased downwards.

There were large number palm shoots and young palms in several areas. Some of these young palm trees were clustered while others appear to be randomly distributed. It appears that there is no harvesting of dried coconuts fallen to ground.

Figure 21: Large number of young palms was growing under canopy in places where sunlight streams in.

DAFOR estimates of the main vegetation varieties are given in Table 5. Boashi and Magoo were abundant on the island and was the main variety on the periphery of the island.

There were cleared paths that appeared to have been used for quite long period of time. According to the proponent, the island was used as a toddy harvesting island, and later as an agricultural island. But the evidence of such an activity is nil.

A dozen or so palms on the western side of the island showed only the stumps without the frond, likely to have been palms that were used to toddy tapping in the past resulting early natural death.

Figure 22: In some areas thick undergrowth was present.

Table 5: Summary Results of DAFOR Survey of common varieties of vegetation on Dhandhoo.

English Name	Divehi Name	Latin Name	D	A	F	O	R
Coconut palm	Divehi Ruh	*Cocosnucifera*	x				
Screw pine	MaaKashikeyo	*Pandanusleucathus*			x		
Sea trumpet	Kaani	*Cordiamoluccana*					x
Pandanus / screw pine	Boa Kashikeyo	*Pandanuslaevis*			x		
Beach Salad	Kulhafilaa	*Launeasarmentosa*				x	
Sea lettuce	Magoo	*Scaevolatacoda*		x			
Beach heliotrope	Boashi	*Messerchmidiaargenta*		x			
Iron wood	Kuredhi	*Pemphisacidula*					x
Bay cedar	Halaveli	*Surianamaritima*					x
Country almond	Midhili	*Terminaliaprocera*					x
Sea hibiscus	Dhigaa	*Hibiscus tiliaceus*				x	
Indian tulip	Hirundhu	*Thespiapopulnea*			x		
Dodder	Velabuli	*Cuscuta approximate*				x	
Cork wood tree	Dhunburi	*Ochrosiaborbomica*				x	
Bigfoot sedge	Hai	*Cyperuscrassips*					
Beach morning glory	-	*Ipomeapes-caprea*				x	
Moon vine	--	*Ipomea alba*				x	

6.6 MARINE ENVIRONMENT

Dhandoo Island is formed on a small oval-shaped lagoonal reef. The focus of the baseline marine environment is the reef around the island. The area surveyed and the locations of various sampling points are shown in Figure 14.

The total reef area of the reef is 15.63hectares, while the area of the island foot print is only 3.25 hectares. The actual vegetated core of the island is 72% of the island footprint and 14.9% of the total reef area. The island sits north-western side of the reef and so lagoon extends into northeast and towards the south (Figure 14).

The island has soft white beaches all round the island. Beach rocks were not present on any part of the island. There was severe erosion on the north/north-eastern and eastern ends of the island. On the western side, and in some places, the high tide line very close or within the vegetation line. Several trees fallen and buried in the inter-tidal area suggests that erosion has been going for some considerable time.

Figure 23: Erosion scarp along the north / north-eastern side was visible, and in some areas high tide mark is close or inside the vegetation line.

Studying earlier satellite images of the island (c.f. Figure 12, Figure 25&Figure 24) and comparing with the current situation it appears that the western side is north and eastern side is being eroded while the island is being accreted ion the west Figure 24).

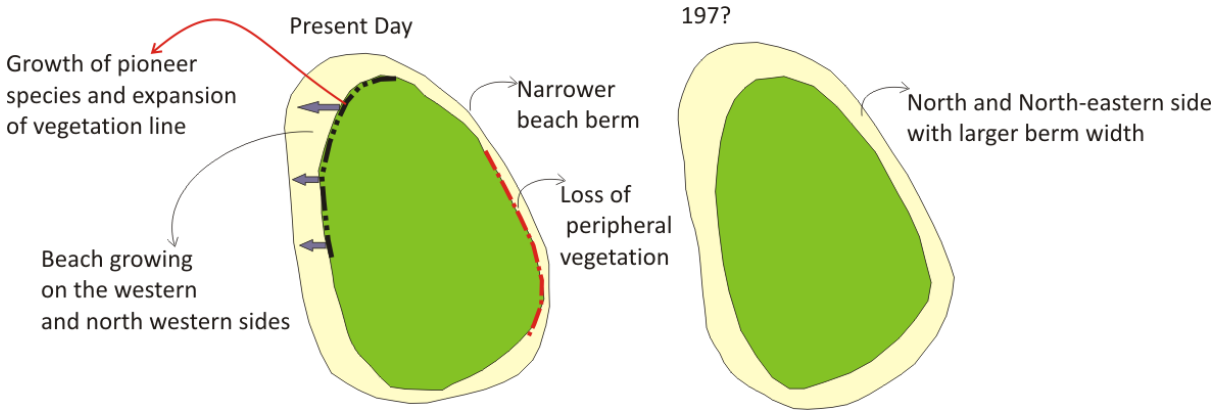


Figure 24: Schematic diagram (to scale as much as possible) to show the change in the morphology of the beach line and growth of new vegetation on the north western side.

The wide beach berm on the northern side shows long stretch of erosion scarps (eroding away areas well above the previous high tide line). On the eastern side, there was no sign of erosion scarp, instead there were signs of establishment of the pioneer plant species (such as bigfoot sedge, beach salad, beach morning glory), signs that vegetation lines is being extended.

It is difficult to clearly establish sedimentary forces that lead to such changes. Kench (2012)[vi] shows that there have been relatively large morphological changes in the beach lines in the islands of Baa Atoll in space of just one year (see Figure 9 of Kench 2012). It appears that such seasonal changes in beaches are geomorphologically important as it regulates the

transfer of sediments to beach and reef growth and also controls the moat area between inner reef flat (Kench, 2012).

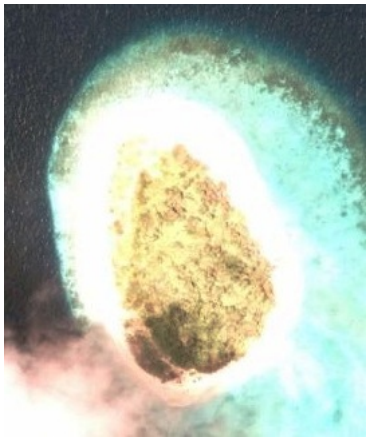
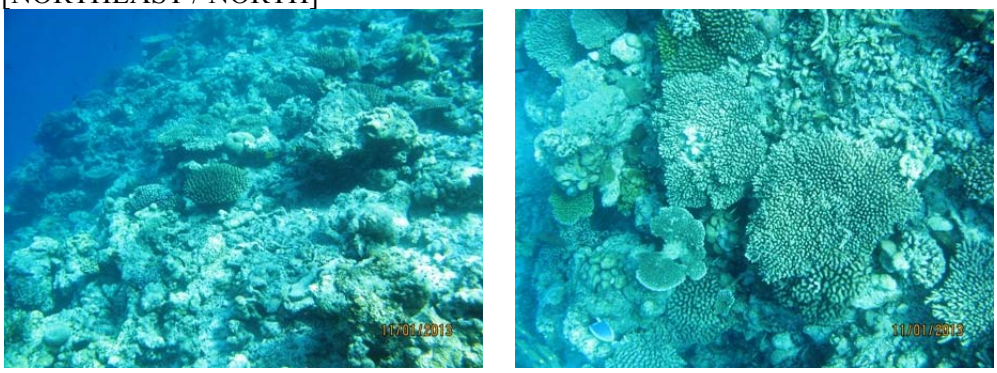


Figure 25: An earlier satellite image of Dhandhoo to show much wider berm on the eastern side indicating there is significant erosion the eastern side.

6.6.1 Photographic Survey

Typical (wide-field) images of the photographic survey are presented in Figure 26. The estimate of the live coral cover is between 8-12%. The live forms and the cover are relatively low compared with the north and north eastern side (<8% on the western side and 8-12% on the north and northeastern side). In fact there appears to be gradation of poor to relatively good live coral cover going from west moving to north and north east.

SITE #1 [NORTHEAST / NORTH]



SITE #2:[WEST]

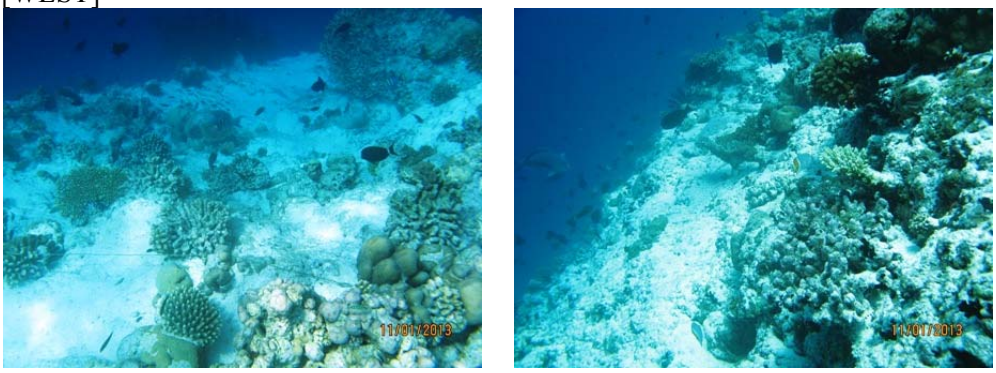


Figure 26: Typical (wide field) images to show representative substrate conditions for site 1 and site 2 (see Figure 14 for area location).

The reef slope is very close the beach on the western side of the island and grades steeply to the atoll floor depth. In some areas patches of isolated finger coral grown on the rocky / sediment lain substrate. On the north and north eastern side, there were areas of lush coral growth and substrate cover. Most of the coral varieties were of finger (staghorn type – Acropora). Some table corals were seen. Smaller colonies ~ 7-10 cm were seen suggesting there is recent recruitment. Overall the coral reef is 'normal' based on the results reported by Zahir et. al (2010)[vii].

6.6.2 Fish Census

A total of 19fish families were recorded at from two the sites with a total of 65 different species. Pooled data are presented Table **6**. It should noted that visual assessment is always an under representation of the true picture. The assessment is notoriously difficult, getting different results by the counter, the time of the day, visibility current etc. So there is lot of potential variability in these assessments.

The counts were done at 14:30. A general observation was that there were more herbivorous fish on the western site. This is expected as live coral cover was much less there.

Table 6: Summary visual assessment survey of common species of fish – both sites combined [C common, A abundant, R: rare]

Family	Species	Abundance
Acanthuridae	*Naso brevirostris*	C
Acanthuridae	*Zebrasoma veliferum*	R
Acanthuridae	*Acanthurus leucosternon*	C
Acanthuridae	*Acanthurus blochii*	R
Acanthuridae	*Acanthurus lineatus*	C
Acanthuridae	*Naso lituratus*	C
Acanthuridae	*Ctenochaetus binotatus*	C
Acanthuridae	*Ctenochaetus striatus*	C
Acanthuridae	*Ctenochaetus strigosus*	C
Balistidae	*Odonus niger*	V Common
Balistidae	*Balistoides viridescens*	R
Balistidae	*Balistoides undulatus*	R
Caesionidae	*Pterocaseio tile*	C
Chaetodontidae	*Chaetodon auriga*	R
Chaetodontidae	*Chaetodon xanthocephalus*	R
Chaetodontidae	*Forcipiger longirostris*	C
Chaetodontidae	*Heniochus diphreutes*	R
Chaetodontidae	*Chaetodon guttatissimus*	R
Chaetodontidae	*Chaetodon klenii*	C
Chaetodontidae	*Chaetodon madagaskariensis*	R
Chaetodontidae	*Chaetodon triangulum*	R
Chaetodontidae	*Hemitaurichthys zoster*	C
Chaetodontidae	*Chaetodon trifasciatus*	C
Chaetodontidae	*Chaetodon trifascialis*	R
Chaetodontidae	*Chaetodon collare*	R
Cirrhitidae	*Paracirrhites fosteri*	R
Heamulidae	*Plectorhynchus orientalis*	R
Pomacanthidae	*Pomacanthus imperator*	R
Pomacentridae	*Abudefduf sexatilis*	R
Pomacentridae	*Chromis dimidiata*	C
Pomacentridae	*Chromis viridis*	C
Pomacentridae	*Dascyllus aruanus*	C

Family	Species	Abundance
Lutjanidae	*Lutjanus gibbus*	R (juv)
Lutjanidae	*Lutjanus kasmira*	C
Lutjanidae	*Lutjanus biguttatus*	R
Labridae	*Thalassoma harwicki*	C
Labridae	*Labroides dimidiatus*	C
Labridae	*Helchoeres cosmetus*	R
Labridae	*Chelinus fasciatus*	R
Labridae	*Epibulus insidiator*	R
Labridae	*Gomphosus caeruleus*	C
Labridae	*Helchoeres hortulanus*	R
Labridae	*Halichoeres hortulanus*	R
Labridae	*Thalassoma lunare*	R
Labridae	*Anampses meleagrides*	R
Labridae	*Bodianus axillaris*	R
Labridae	*Bodianus diana*	C
Labridae	*Halichoeres vrolikii*	R
Labridae	*Halichoeres leucoxanthus*	R
Labridae	*Halichoeres scapularis*	R
Labridae	*Pseudochelinus envanidus*	R
Labridae	*Pseudochelinus hectaenia*	R
Labridae	*Stethojulis albivittata*	R
Lethrinidae	*Monotaxis grandoculis*	R
Mullidae	*Parapeneus bifasciatus*	R
Nemipteridae	*Scolopsis bilineatus*	R
Scaridae	*Cetoscarus bicolor (male + females)*	C
Scaridae	*Scarus frenatus*	C
Scaridae	*Scarus gibbus (males + females)*	C
Scaridae	*Scarus niger*	C
Serranidae	*Cephalopholis argus*	R [juv]
Serranidae	*Anthias spp.*	R
Siganidae	*Siganus puellides*	R
Synodontidae	*Synodus variegatus*	R
Zanclidae	*Zanclus cornutus*	C

Table 7: Summary visual assessment of fish species on Dhandhooreef , two sites combined.

Family	#Species	Family	#Species
Labridae	18	Cirrhitidae	1
Chaetodontidae	12	Heamulidae	1
Acanthuridae	9	Pomacanthidae	1
Pomacentridae	4	Lethrinidae	1
Scaridae	4	Mullidae	1
Balistidae	3	Nemipteridae	1
Lutjanidae	3	Siganidae	1
Serranidae	2	Synodontidae	1
Caesionidae	1	Zanclidae	1
Total	56	Total	9

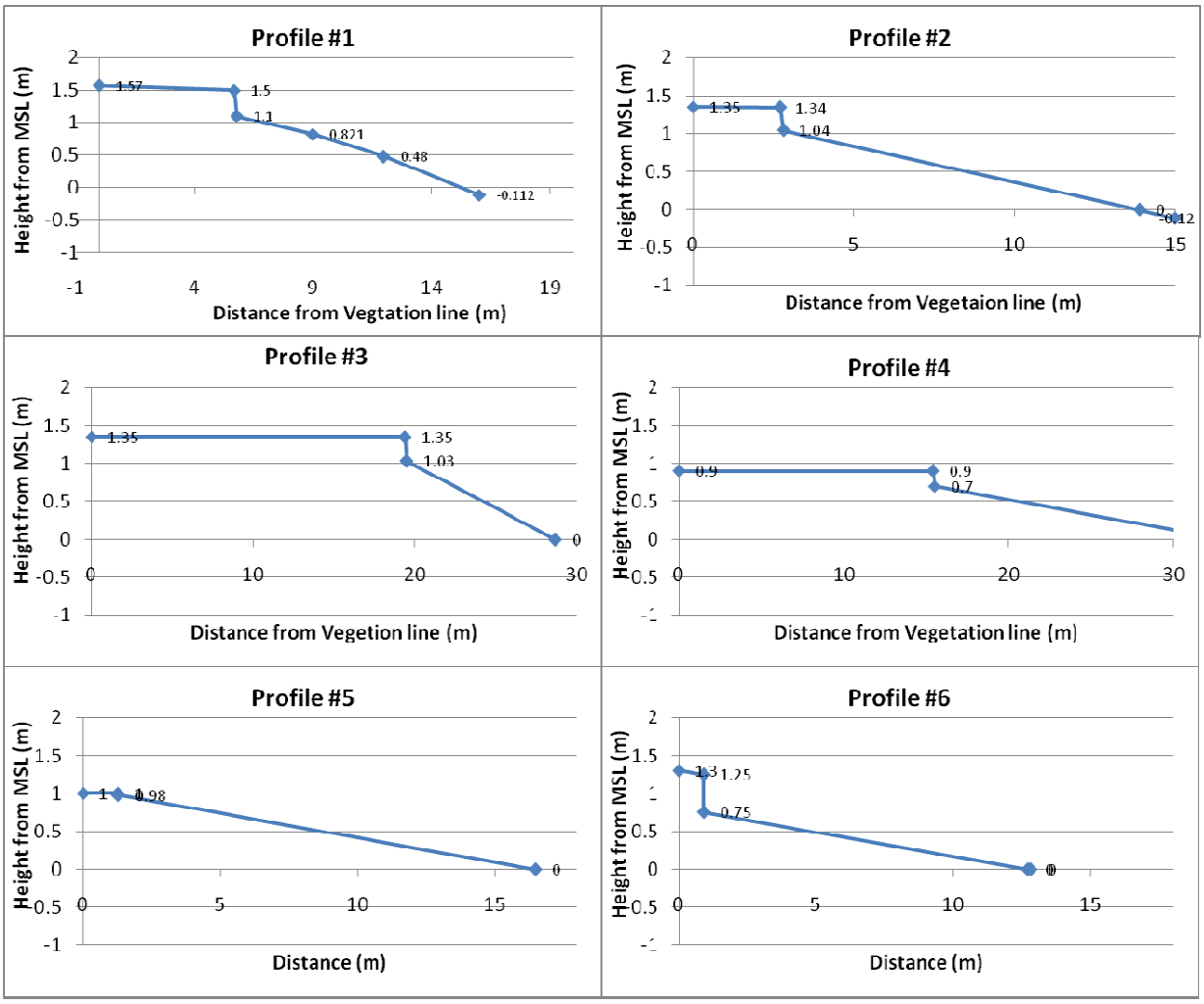
There were large number of *Odonusniger* (the red-tooth trigger fish), and this is more visible on the western site. Large schools with literally thousands were hovering on the slopes.

Figure 27: There are large numbers of red-tooth trigger fish (*Odonusniger*) on the west and in some section of the north eastern section of the reef.

Figure 28: Algal grazing (herbivory) is common in area of dead reef where Scarid (parrot fish) grazing is common (left panel).

6.6.3 Beach Profiles

A total of six beach profiles were obtained at different points along the shoreline (c.f.Figure 14). The erosion scarp is visible in most of the profiles. Profiles #3 and #4 have wider berms with very clear erosion scarps (Figure 23).



6.6.4 Marine Water Quality Tests

Marine water samples were collected from the lagoon on the western side. The results provided by the laboratory are given below and in Annex 5.

Parameter	Lagoon Water, Point #8
Temperature (°C)	29.5°C
pH	8.20
Salinity	26.15
Electrical Conductivity (µS/cm)	47000
Total Dissolved Solids	23500
Total Suspended Solids (mg/L)	0

6.7 VULNERABILITY TO NATURAL HAZARDS

Maldives is situated on the equator and so the climate induced natural hazards are a somewhat rare phenomenon. However, the 2004 tsunami demonstrated the Maldives can be extremely vulnerable to natural hazards, albeit extremely rare. Following the tsunami the

UNDP undertook a detailed, but very first study, of disaster risk of islands in the Maldives[viii]. Assessment of complete range of the vulnerabilities in Maldives with reference to multiple hazard events is given in the report. The Appendix II of the report provides the scores of various hazards given for each of the island. Here for the purposes of this report, the data for Baa atoll is provided (Figure 29).

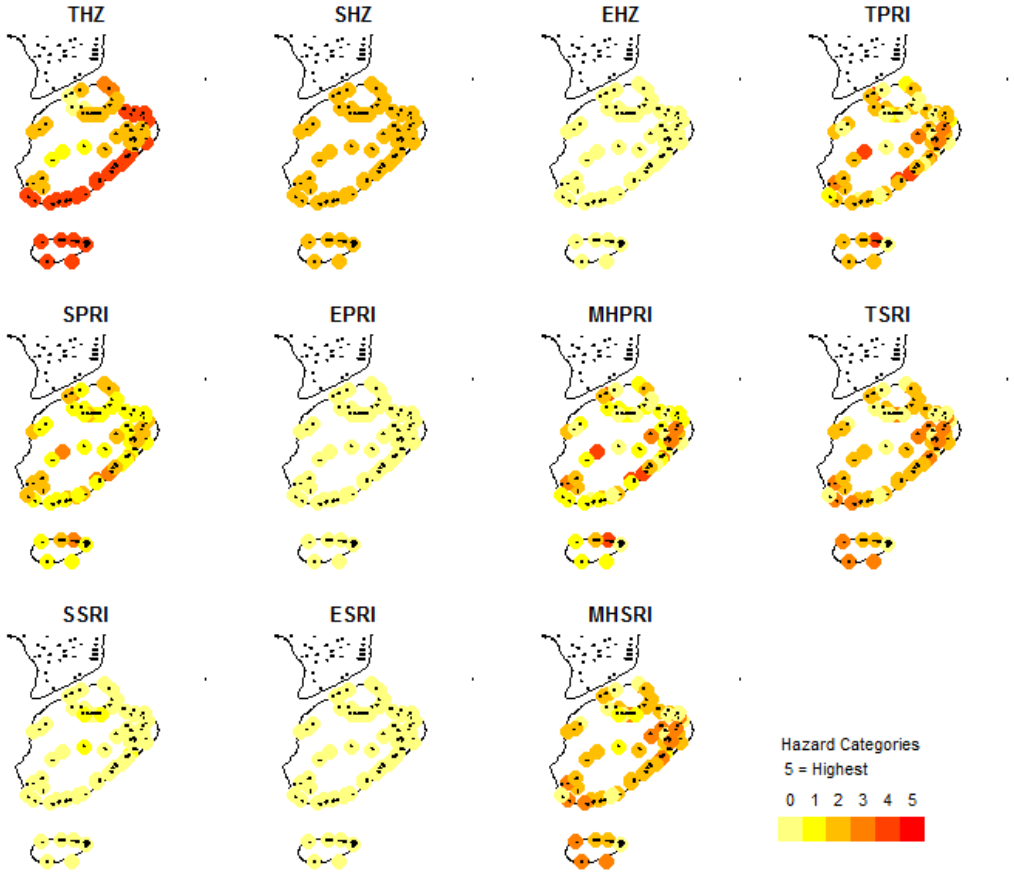


Figure 29: Summary of Hazards and Risks for the island of Baa Atoll. Acronyms are: Tsunami Hazard Zone (THZ), Storm Hazard Zone (SHZ), Earthquake Hazard Zone (EHZ), Tsunami Physical Risk Index (TPRI), Earthquake Physical Risk Index (EPRI), Multi-Hazard Physical Risk Index (MHPRI), Tsunami Social Risk Index (TSRI), Storm Social Risk Index (SSRI), Earthquake Social Risk Index (ESRI) and Multi-Hazard Social Risk Index (MHSRI). Data Source: UNDP (2006).

The development project area appears to be in a high tsunami high hazard zone and the Tsunami Social Risk Index (TSRI) and Multi-hazard social risk index is also relatively high. The latter two risks are associate with the community's abilities to deal with the such hazards.

6.8 SOCIO-ECONOMIC ENVIRONMENT

6.8.1 Geographic Context

Baa atoll is one the more prominent atolls in the Maldives. The atoll is well known for its educated population and special skills of the wood –lacquer work. Like all the atolls of the

Maldives, people are also fishermen by tradition. There are some islands, for example, Thulaadhoo, quite popular for tuna fishing.

Probably of the atolls that took the full advantage of the mechanization and its regular transport to Malé was Baa Atoll. Many well-to-do families emigrated Malé, but keeping their ties with families back home. The result was the quite rapid economic development in the many islands, particularly on the administrative Island, Eydhafushi.

The arrival for tourism in the Baa created greater impetus for economic development with teh employment opportunities provided in the resorts. The 2006 census showed there were close to 500 people working in the resorts.

Presently there are 7 resorts (Coco Palm, Sonevafushi, Royal Island, Kihaadhuffaru Resort, Reethi Beach, Landaagiraavaru, Kihaava-huravalhi) in operation in Baa Atoll, Two more are planned.

Recently the atoll was declared a Biosphere Reserve under UNESCO's Man and Biosphere Programme[ix]. The declaration of the biosphere reserve and marine protected areas with rich biodiversity in the atoll is helping to boost the tourism in Baa Atoll. More recently operation of the domestic airport on Dharavadhoo would provide further stimulus to socio-economic development of the Baa Atoll communities.

6.8.2 Population Structure

The data for the last two censuses is presented in Figure 30. During 2000 census 9,612 people were reported to be living in Baa Atoll. The figure in 2006 was 9560 showing a declining resident population. It was clear there was net emigration of the population and nearly all were to Malé seeking better socio-economic living conditions.

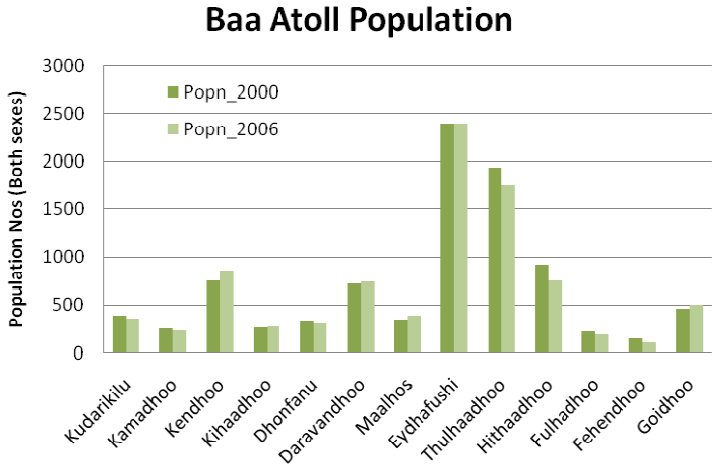


Figure 30: Population of Baa Atoll by island estimated in the 2000 and 2006 census. Source: Department of National Planning,

6.8.3 Agricultural Activities

Agricultural activities on Baa atoll appear to be very limited. There are few islands that do any form of serious agriculture work. Records show that three islands have been identified as agriculture (commercial islands). These are Hibalhidhoo (close to Maalhos), and Miladhoo and Fares (on the western side). Details of the agriculture production was not available, but it is assumed very few (or none) of the produce of these island are targeted for sale to resorts in the atoll.

Veyofushi island, not far from Dhandhoo in the south west is also being developed as an agricultural island using hydroponics and AutoPot systems. It is suggested that the proponent explore how synergies can be build with Veyofushi project.

6.8.4 Fishery Activities

Baa Atoll used to be tuna fishing atoll. During early days of mechanization the fishermen of Baa Atoll were active in supplying fish to the Felivaru Cannery. Those days Thulaadhoo, were quite popular fishing Island.

The traditional form of tuna fishing has rapidly been taken over by tourism and the socio-economic developments that took place (Figure 31). The most recent census shows that there are over 500 people directly employed in the resorts. That was in 2006 with few resorts. Now with 8 resorts the employment opportunities of communities must be greater.

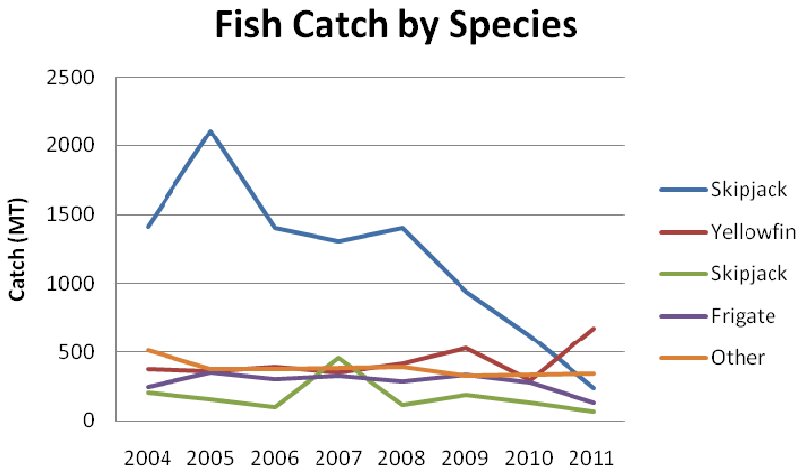


Figure 31: Trends in catches of major varieties of fish in for Baa Atoll; Source: MoFA Statistics.

Fishing in the atoll has shifted from the traditional form of pole-and-line fishing to more artisanal type reef fish fishing. The vessels engaged in fishing are small and low-tech target popular reef fish varieties; jacks, job fishes, snappers, breams etc. These days scad fishing is also very popular. Many resorts also employ staff for fishing, but often they contract out the work to communities, benefiting them enormously.

These livelihood changes are actually important in the context of the resource exploitation and sustainability. Baa atoll being the first atoll to declare as a biosphere reserve in the Maldives is seen as a model atoll for community-based management of natural resources.

It is hoped that developments in Dhandhoo and Veyofushi of small/medium scale climate-smart agriculture developments will help to further improve the socio-economic status and thereby demonstrating the value for developing small island that are still untouched in the Maldives.

6.8.5 Tourism Activities

Baa Atoll has now 8 resorts with total bed capacity of 1,638. Most of these are high-end resorts. Recent declaration of the Baa Atoll as a biosphere reserve and popularity of Hanifaru Bay aggregations is expected further boost the popularity of the Atoll.

Table 8: Tourist Resorts on Baa Atoll and their bed capacity.

island_ID	Name	No_Beds
BA40	Kihaad Resort	224
BA56	Royal Island	304
BA67	Soneva Fushi	130
BA72	Coco Palm	200
BA55	Reethi Beach	248
BA16	Four Season's Landaagiraavaru	214
BA39	Kihaavahuravlhi	110
BA50	Mudhoo	208

7 POTENTIAL IMPACTS AND MITIGATION MEASURES

Various methods are available to identify the extent, magnitude and significance of socio-economic and environmental impacts of a development project, for instance checklists, matrices, expert opinion, modeling etc. Impacts from various activities of the proposed project both construction and operational phases have been identified through consultation with the project management team, field surveys, observations and assessment, as well as based on field experience and expert opinion on similar development projects in the country.

Other sources of information have been used wherever possible. Data collected during field surveys can be used to predict outcomes of various operational and construction activities on the various related environmental components. Data presented in this report can also be used as a baseline for environmental monitoring of the project activities.

Possible impacts arising from the construction and operation works are categorized into reversible and irreversible impacts. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories

- **Negligible:** the impact is too small to be of any significance (Reversible)
- **Minor:** the impact is undesirable but accepted (Reversible)
- **Moderate:** the impact give rise to some concern but is likely to be tolerable in short-term, or will require value judgment as to its acceptability (Reversible)
- **Major:** the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project (Irreversible)

Leopold Matrix [x] has been used to classify the magnitude and importance of possible impacts which may arise during the constructional and operational phase of the Dhandhoo agriculture project. Leopold Matrix is the most widely used methodology for identifying the impact of a project on the environment. It is a two dimensional matrix which cross references between the activities which are foreseen to have potential impacts on the environment and the existing conditions (environmental and social) which could be affected. Leopold Matrix of Dhaandhoo project is provided Annex 6.

7.1 MAJAOR IMPACTS AND MITIGATION MEASURES

7.1.1 Construction Phase

Impacts from Mobilization of Equipment and Workforce: Clearing of vegetation would be necessary to setup the small workforce about 10-20 workers. If proper attention is not paid workers in the island could easily disturb the island fauna. Inappropriate land disposal of domestic and sewage waste has the potential to degrade and pollute the local aquifer. The plastic wastes generated will be stockpiled away from the construction site until the Island's waste management system become fully functional. The food wastes will be composted even during the construction phase Disposal of hazardous waste and sewage may be a concern if not appropriately dealt with.

Mitigation Measures:

- Areas should be clearly marked for construction activities.
- A specific area should be designated in the coastal area for landing and material loading/unloading.
- Vegetation that needs to be retained must be clearly marked and communicated to the construction workers.
- Signs should guide workers to proper environmental care.
- A portable desalination plant should be installed for potable water
- The supervisor should check compliance of the workers to the environmental guidelines set for the project including avoidance of removal of unmarked vegetation, proper waste management, marine water pollution and ground water pollution.

Clearing of vegetation:

Clearing of vegetation for the development of 4 Greenhouse, nursery, water and fuel tanks, laboratory, crops and fertilizer storages, cool rooms, staff accommodations, kitchen, dining room, powerhouse, desalination plant, office, mosque, recreation room, herbal treatment center will significantly alter the existing landform characteristics. It will inevitably result in the loss of about 7% of the island's vegetation. It should be noted however that the natural vegetation of the island has already been to a large extent modified by the human activities. The dense coconut grove of the island appeared to be randomly distributed due to lack of regular harvesting. The existing flora is not considered unique or particularly unusual. Main negative effects of clearing of vegetation will include reduced number of resident birds and bird visits to the island, reduced open space qualities, reduced scenic views and vistas, alteration of the local climate and exposure of island soil for erosion.

Mitigation measures for loss of species:

- Any large tree or shrub that fall within the allocated area for various infrastructure developments will be made available for replanting elsewhere in the island.
- Vegetation clearing will be conducted in stages so that clearing will take place only when required;
- Introduction of plants from abroad will be avoided instead plants in the infrastructure development plots will be relocated to appropriate areas;
- An appropriate education program among workers to refrain from damaging vegetation unnecessarily;
- Avoiding use of imported cow dung manure or inorganic fertilizers for landscaping purposes; and
- Prohibiting catch and keeping birds (except poultry) and exploitation of turtle nests on the Island by the workers;
- Most of the large and mature trees removed will be made available for replanting elsewhere in the island.
- Strict guidelines and construction monitoring is required during the vegetation removal stage to ensure that every single large tree could be replanted.

- All clearing works will be carried out during day time to minimise disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication.

Coastal development Works:

Jetty: Installation of the solid coastal structures has the potential to adversely modify the dynamic sediment transport regimes. The proposed development in Dhandhoo Island does not involve construction of such permanent solid coastal structures. The island will only have a jetty standing on pillars or stilts on the western side of the island. This development will have negligible impact on the coastal processes of the island and might make minor alterations to the current and sediment regime.

CAM treatment rooms:
CAM treatment rooms are planned to be built on the foreshore on north eastern beach of the island. Although the structure would be on still piles/columns, there would be the effect of the columns on the longshore sediment transport and minor alteration to the nearshore current flow. Since the structures are shore connected, there will be some degree of disruption of natural sediment transport patterns at the base of the deck. This impact would be greater in the proposed area due to the dynamic nature of the area. However the longshore processes will reach a new equilibrium through time and the structures are not expected to affect longshore transport dramatically. The impact will be considered minor negative or positive given that there may be some accretion below the structures, which may be desirable from a management perspective. There will not be any direct impact on corals as no structures would be built on live corals or no live corals would be moved.

Noise, Vibrations and Air Pollution

The types of noise generated from the operational development of Dhandhoo are unlikely to affect fauna in adjacent habitat, although monitoring of impacts on significant species of other elements of the development, such as water quality and habitat disturbance due to the operation of roads or pathways. During the mobilisation of equipments and operation of heavy machinery for vegetation removal, it is anticipated that significant noise will be generated. In addition, dust and emissions from vehicle and machinery exhausts will degrade the air quality. With proper mitigation measures, it is unlikely that noise and air pollution impacts will cause long term effects such as human health risks leading to increased public and private health costs.

Mitigation measures:

- All construction works will be carried out during day time to minimise disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication.
- All vehicles and machinery will be tuned and well maintained to minimise air pollution
- To minimize dust from construction works ground/soil will be kept damp.

Greenhouse Gas Emissions

Vegetated areas are known to act as carbon sinks for greenhouse gases particularly carbon-dioxide. The proposed project involves clearing of vegetation during site preparation. However, the removed large trees are planned to be replanted in other areas of the island.

On-site diesel engine generators will be the main source of energy for operating machinery such as desalination, pumping, heating, cooling, drying and lighting at the island. This would contribute to air pollution and greenhouse gas emissions.

Savings on electricity will be achieved through energy saving lights installations, use of energy efficient appliances and by placing awareness rising messages at the appropriate locations of the island.

Mitigation Measures:

- All mature trees will be re planted where possible.
- Only vegetation that is absolutely necessary to be removed will be cleared.
- Waste will be properly stockpiled temporarily on site and disposed at a designated disposal site.

7.1.2 Operational Phase

Brine from desalination unit

Dilution of the small volume of brine produced by the RO units and discharged into the outer back-reef area will require a very small mixing zone. The intake structure will be buried within the lagoon. The discharge structure will be placed about 10 - 15m away from the reef flat where mixing of the discharge with the seawater will be greatest. The adverse effects to marine resources of desalination plant discharges will depend on the total volume of brine being released; the constituents of the brine discharged. The constituents of discharges of particular concern for marine organisms include biocides, high metal concentrations, and low oxygen levels. However, many of these issues can be solved simply by choosing the right technology. The brine discharge from the desalination plant might have a minute heating effect in the vicinity of outfall pipe. Such a small amount of heating would have no significant impact on the marine and coastal environment.

Wastewater

Disposal of untreated wastewater on land or marine environment has the potential to produce various adverse effects. Disposal on land can contaminate the groundwater while disposal into nearshore can cause eutrophication leading to development of seagrass meadows or various algae. In order to prevent problems which can arise due to disposal of untreated wastewater into the environment, all the wastewater from toilet flushing, will be collected via a system of gravity lines, junctions and pumping stations to a central septic system for treatment and disposal.

Septic tank system will be used only for treating toilet effluents. The septic system, when performing properly, safely treats and disposes of sewage without creating any danger to human health or to the environment.

The typical septic tank is divided into two chambers; the larger chamber will receive toilet effluents and this portion of the septic tank will provide a relatively quiescent body of water where the wastewater is retained long enough to let the solids separate by both settling and flotation. The scum will float on top of the water surface in the tank forming scum layer while the sludge will settle to the bottom of the tank forming sludge layer. The liquid layer or the effluent layer found in the middle of the top and the bottom layer will pass through a wide opening into the smaller portion of the tank from where it will flow into the soil absorption unit through a pipe. Based on experience, and considering the number of expected regular users of the toilet facilities a septic tank of this magnitude is expected to be in good condition for a period of 10-15 years. Figure 32 shows the septic tank design proposed to be used at the island.

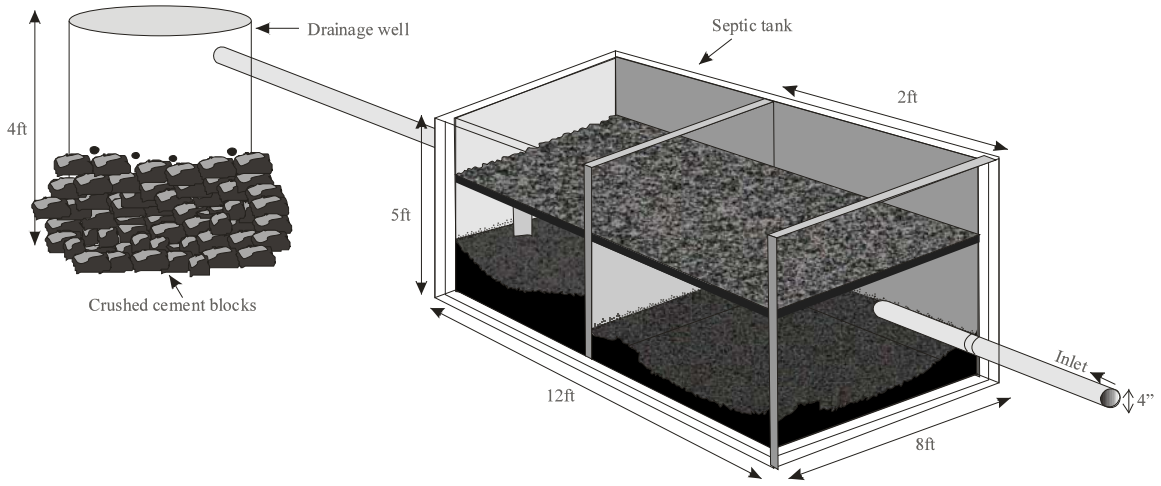


Figure 32: The proposed septic tank design

To lengthen the "retention time", - of the wastewater in the septic tank for enhancing purification, all possible measures will be taken to reduce unnecessary discharge and too a large a volume of water at once into the septic tank. Therefore, the amount of water entering the septic system will be controlled through the following practices.

The laundry and kitchen wastewater will not be allowed into the tank instead it will directly pass into drainage well. If allowed into the septic tank the laundry wastewater is believed to slow down the microbial processes in the tank.

Potential Spills of Fuel, Lubricants and Oily Wastes

The tank farm will be contained in a bunded area to prevent diesel from entering the island's aquifer in the event of refueling mishaps and leaks. The need for regular fuel transfer from visiting inter-island tanker will provide a small but significant spill risks from the tanker itself and from the refueling operations. The risk can be considered significant owing to the sensitivity and high economic value of potentially affected habitats in the immediate area such as coral reefs and beaches.

The risks of major oil spills following accidental collision or grounding in the project area is low owing to:

- the sheltered intra-lagoon waters which form the approach route to the project area;

- the use of daylight arrival and departures times to maximize navigational safety;

In the unlikely event of a large spill of diesel fuel, any use of dispersants would be highly unadvisable owing to the proximity of shallow coral reefs and total absence of mangroves in the project area. Diesel fuel has a high evaporation rate, and very fast weathering process in well oxygenated, warm and sunlit tropical waters are well known. Therefore main effect would be short-term, such as oiling to local seabirds and beaching of the heavy residues on the local beaches.

In addition, careless or inappropriate handling of lubricants, grease and solvents in the work areas or from speed boats or Dhonis engines maintenance has the potential to pollute the local aquifer and deposit tarry products on local beaches respectively. All lubricants and oily wastes will be taken to the waste processing unit for incineration.

Potential Positive Impacts

AutoPot Hydroponics: AutoPot hydroponics is a relatively new versatile technology perfect for growth of agricultural crops in controlled environment (polythene greenhouses). This is a very appropriate technology for Maldives as the country lacks suitable land for agriculture, the soil is poor in moisture and nutrient retention and the ground water is very salty not suitable for hydroponics. However the high annual rain fall 100cm/yr makes hydroponics possible. The technology has already been tested and used by the "Seagull Group" in the Maldives. AutoPot hydroponics system has the following positive impacts on the environment:

- Water Efficiency. Every drop of water that goes via the Smart valve to the growing container is available to the plant. The single minimal wastage of water is through evaporation from the surface of the container. There is no run-off and no recycling of water.
- Watering According To Demand. The AutoPot dictates that the amount and frequency of water provided is exactly as the plants require
- AutoPot system used in Dhandhoo will use overhead water tank gravity fed system.
- Self-scheduling irrigation cycle caters exactly for the plant's ever changing needs throughout the year creating seasonal cycles akin to monsoon season.

- No potential significant contamination issues

The cumulative beneficial impact of the development will use AutoPot hydroponics agriculture to the Maldives which help contribute to the food security and self sufficiency of the country. Other beneficial impacts are:

The development of Dhandhoo will maintain GDP growth by providing a range of direct and indirect economic and social benefits at the national and local levels.

Direct economic effects include increased government revenue and increased employment opportunities. Indirect economic effects will include increased earnings and employment by the island's support infrastructure development including the construction, supply, transport service and agriculture industries.

Local benefits would include, increased wage employment opportunities particularly for the communities in Baa Atoll

The isolated location, size and habitat of Dhandhoo agriculture project contribute favourably to the environment. The project cause no distraction to social life, no disruption of protected areas or heritage and the benefits of the Dhandhoo agriculture project will substantially outweigh its negative impacts on the environment.

7.1.3 Limitation or uncertainty of impact prediction

Environmental impact prediction involves a certain degree of uncertainty particularly when applying new technologies in agriculture. Impacts can vary from place to place due to even slight differences in ecological, or social conditions in a particular place. Uncertainties of impact prediction are mainly due to the lack of long term experimental data, inherent complexity of ecosystem and availability of similar case studies from elsewhere. There is also limited data and information regarding AutoPot hydroponics particularly about the impacts of nutrients and chemicals that are used in this technology, which makes it difficult to predict impacts. Available literature and case studies elsewhere clearly indicates that this is one of the best technologies commercially available, and perfectly suitable for the environmental conditions of the Maldives. Therefore, the level of uncertainty, in the case of Dhandhoo as per the available literature on this issue indicates that this is a very positive and very beneficial technology for the Maldives.

The other impacts are predicted by reviewing the survey data collected during the field visits and based on the experience of similar project activities in the country. Therefore, there is very little uncertainty involved in this project with regard to the use of AutoPot hydroponic agriculture technology and there is a high degree of accuracy in prediction of the remaining impacts of the project.

8 ALTERNATIVES

8.1 NO DEVELOPMENT OPTION

With and without Project (No Development) scenarios were investigated primarily regarding environmental conditions on the Island. In the absence of a good management system on the island, similar to the existing situation, exploitation of the island's resources such as unsustainable cutting down of trees, unattended coconut harvests is expected. With the inception of the project, the island's environment is expected to be better managed and improve.

No Project would mean a loss of potential economic activity that can provide earnings to the national and local economy. It also means that with no project option there would be no impact on the marine and terrestrial environment of Dhandhoo from development of this project.

To go ahead with the project means there would be economic activity to generate revenue to the country through related business and increased employment. Undoubtedly to go ahead with the project will result in some level of impact to the natural environment and the purpose of this EIA exercise is to make those impacts as minimum as possible and to suggest mitigation measure to abate those impacts.

8.2 DEVELOPMENT OPTION

Having decided and followed the development option for Dhandhoo AutoPot hydroponic agriculture project one has to consider the alternative options in Dhandhoo that would have least environment impact. Following have been considered for the alternatives.

8.2.1 Design alteration

Relocation of CAM treatment rooms:

Dhandhoo is a very dynamic island where the beach sand shifts seasonally from one side to the other. Therefore the development of the herbal treatment room on the foreshore of the North eastern side of the island might interfere with the sediment dynamics of the island and may reshape the island or cause erosion. Therefore it is recommended to relocate treatment rooms to the vegetated area of the island.

Staff accommodation and powerhouse:

Junior and senior staff accommodations are close to the powerhouse and desalination plant house. Although the powerhouse is sound proofed human health risk may arise due to emissions from powerhouse exhaust. Therefore it is recommended to shift staff accommodation blocks away from the powerhouse and desalination plant house.

Fertilizers room and temporary storage area for harvest:

Fertilizer room and temporary storage area for harvested crops are adjacent to each other. Fertilizers attract rodents and other organism that feed on them. Keeping these two rooms adjacent to each other may cause occupational health and hygiene issue as the organisms living and feeding on fertilizers may transfer unwanted illnesses to the harvested crops and may cause an outbreak. Therefore it is advised to move the temporary storage area for harvested crops away from the fertilizer storage room.

9 MONITORING

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

9.1 OBJECTIVE OF MONITORING

The main objectives of the monitoring plan are:

- To verify effectiveness and the accuracy of the predicted impacts and mitigation measures and adjust the response accordingly
- To identify observe and response to unforeseen impacts in a timely and appropriate manner at the earliest
- To eliminate or reduce environmental costs

9.2 MONITORING PARAMETERS

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include ground water (pH, dissolved oxygen, electrical conductivity, total oil (Hydrocarbon) and faecal coliforms), water quality (turbidity, dissolved oxygen, phosphates, nitrates and BOD), and coastal dynamics associated with coastal developments.

Table 9: Environmental Monitoring Program for Dhandhoo AutoPot hydroponic agriculture project.

Indicators	Measuring parameter	Survey Technique	Frequency	Baseline/References	Cost (USD)
Island Dynamics	Shoreline changes 1m/yr erosion and accretions sand shifting pattern	DGPS Survey	Bi-annual	Baseline data available for this study	500.00
Coastal dynamics	Changes in beach	Beach profile surveys	Twice a year	Baseline data available for this study	750.00
Ground water Quality	Salinity, pH, Nitrate (ug/l), Ammonia, Chloride, Phosphate, COD, colliform and faecal colliforms	Sampling and Laboratory Analysis	Once a month	Baseline data available.	50.00

9.3 MONITORING REPORT

Based on the data collected, a detailed monitoring report will be compiled annually and submitted to the relevant government authorities for compliance. The report will include methodologies and protocols followed for data collection and analysis, quality control measures and indicate the uncertainties.

9.4 MONITORING COSTS

It is understood that costs of monitoring be borne by the developer. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment from the proponent is given Annex 4

10 STAKEHOLDER CONSULTATION

Stakeholder consultation took place at two levels; one at the atoll council level and the other at the tourist resort level. The terms of reference required a consultation with the Atoll Councils levels only. Due to busy schedules of the Councillors it was difficult to meet with them in the Eydhafushi. Instead through the Councillor Mr. Ibrahim Rasheed a meeting was organized in Malé.

At the Councillors Meeting two people were present; Council Member Mr. Ibrahim Rasheed and Vice President of the Council. Mr.Abdul Rahman Abdullah along with Dr. Mahmood Riyaz also took part in the meeting. The councillors were quite satisfied with the Project. Mr. Abdul Rahmaan re-affirmed that he does not see any issues with this proposal on Dhandhoo. Once the report is submitted to the Council Office and official communication endorsing this project will be issued.

One of the key stakeholders in the Biosphere Reserve is the tourist resorts. A small write up was made (Annex 3) explaining about the project and the importance of their views. At the time of this writing only Reethi Beach Resort responded. Their comments were that a similar project was being developed on Veyofushi and that the project may need to coordinate to see if there were synergies. Also he was concerned about the visible infrastructure development above the canopies. Both issues have been addressed in the report.

Figure 33: Stakeholder Consultation took place in local café in Malé

11 SUMMARY AND CONCLUSIONS

Dhandhoo is a small island located in Baa Atoll Biosphere Reserve Atoll surrounded by five important tourist resorts. The island has relatively dense vegetation, typical of small uninhabited islands. Around 650 coconut palms are present spread out but somewhat clustered in the eastern side of the island. Most of the palm trees had few fruits showing the relatively poor yield of the palms. The central but more western section of the island was used for agricultural purposes and later some of the palms were used for tapping toddy.

The marine environment is dominated by the reef and the lagoon typical of any island in the Maldives. The reef edge is only few meters to the beach on the western side. However, the lagoon is well developed in the east and south. Average depth of the lagoon is around 1.5 – 2.0 m at MSL.

The live coral cover on the reef is average; poor growth on the western side, but substrate cover improved one on the north and eastern side. The reef slope grades sharply almost on every point surveyed.

Comparing from earlier satellite imagery on Google Earth and with present conditions, the island appears to be shifting to west. However, literature shows that such level of beach dynamics occur seasonally. There is significant erosion on the eastern side and accretion on the western side. The berm width is about 20+ m on the western side where as on the east it is ~ 2m. Pioneer plant species have established newly stabilized dunes on the western side.

The main developments proposed are 6 x green houses that will employ climate-smart type agriculture to grow high quality products such chilly, lettuce, tomatoes, cucumber, and rock melon. Additional facilities on the island include a small centre providing complementary and alternative medicine treatments and also small nursery to grow indigenous medicinal plants.

Development impacts are minimal and will be limited to clearance and removal of the vegetation on the proposed development area. About 60-80 coconut palms will have to be relocated during site clearance. A small jetty on stilts is proposed on the western side, which should not impeded water movement and should be insignificance.

The environmental impacts, in order of significance are:

1. Loss of vegetation – becomes negligible over time.
2. Potential to contaminate the ground water aquifer in the long term, from sewage and or liquid fertilizers and chemicals used in for climate-smart agriculture and in the nursery.
3. Introduction medicinal plants – unlikely to have an impact.

This development is expected to have only minimal negative environmental impact to the island and it ecosystem. The positive impacts from this development is that island is used for economic purposes rather that leaving for misuse by the public as indicated by the

irresponsible littering on the island. The produce on the island is going to contribute agricultural production in the country and demonstrating sustainable use of Baa Atoll Biosphere Reserve. Overall, the positive aspects of this development outweighs the negative environmental impacts that of short term and insignificant.

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12 ANNEXES

Annex 1: Approved Terms of Reference of the project

Annex 2: Preliminary Layout plan of the Dhandhoo Development Project.

Annex 3: Instructions given to the resorts for the Stakeholder Consultation Questionnaire.

Annex 4: Commitment Letter from the Developer + letter indicating the communication on EIA work

Annex 5: Water Test Results from NHL and MAWC + the letter from MAWC stating tests they are unable to do.

Annex 6: Leopold Matrix (Impact Matrix) for Dhandhoo Development Project.

Annex 7: AutoPot Commercial layout for $400m^2$

Annex 8: List of participants by island, attended at the Community Consultations.

13 REFERENCES

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