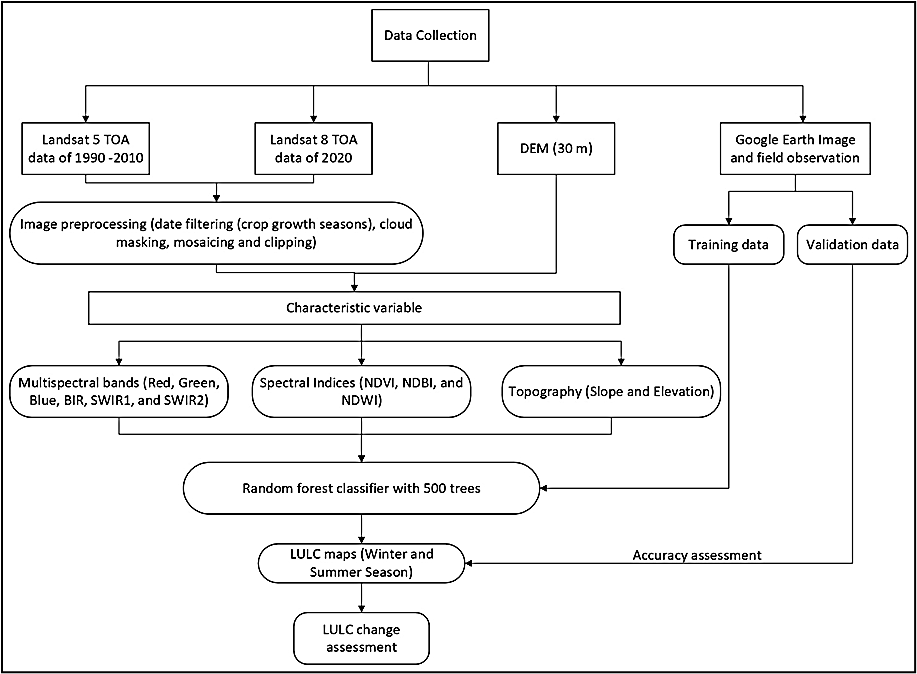
**Analyzing Land use land cover (LULC) changes induced by Run-of-the-river schemes using Google Earth Engine and respondent survey: case study of Ghazi Barotha Hydropower Project, Pakistan**

**Supplementary Information**

**S1. Remote sensing process diagram**



**S2. Location delineation**

Location identification and delineation targeted all the communities living on both sides of Indus river downstream of GBHP, as declared by Water and Power Development Authority (WAPDA), as beneficiaries of groundwater development schemes. Delineation accompanied selecting boundaries of the communities’ respective village boundaries along the river. (Output: Figure 1). Watershed delineation is done by using DEM data through ArcGIS (10.8)

**S3: Input data**

Following table illustrates details of input data for Remote sensing used in this study:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **Satellite** | **Sensor** | **Resolution** | **Acquisition date/ Season** | **Cloud Cover (%)** |
| 1990 | Landsat 5 | TM | 30\*30 meters | February 1990 (Winter) | 2 |
| August 1990 (Summer) | 1 |
| 2002 | Landsat 5 | TM | 30\*30 meters | February 2002 (Winter) | 3 |
| August 2002 (Summer) | 4 |
| 2010 | Landsat 5 | TM | 30\*30 meters | January 2010 (Winter) | 1 |
| August 2010 (Summer) | 3 |
| 2020 | Landsat 8 | OLI/TIRS | 30\*30 meters | February 2020 (Winter) | 2.4 |
| July 2020 (Summer) | 2 |

**S4. Google Earth Engine Pre-processing, Classification and Validation codes**

var roi = /\* color: #d63000 \*/ee.Geometry.Point([72.56723341384935, 34.01160201957689]),

water = /\* color: #1c76ff \*/ee.FeatureCollection(

[ee.Feature(

ee.Geometry.Polygon(

[[[72.63592440053151, 34.01402043891745],

[72.6344652788274, 34.013842575934255],

[72.63472277089284, 34.012739817121556],

[72.63678270741627, 34.01316669319978],

[72.63641792699025, 34.014038225195264]]]),

{

"LandCover": 0,

"system:index": "0"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.54707071154651, 33.99656988561552],

[72.5462767776781, 33.996196296165074],

[72.54674884646472, 33.99582270507182],

[72.54786464541492, 33.99630303617569],

[72.5472852882677, 33.996712204974024]]]),

{

"LandCover": 0,

"system:index": "1"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.48467561496929, 34.01501686491186],

[72.48375293506817, 34.014945720598284],

[72.48392459644512, 34.01440324324692],

[72.48528715862469, 34.014421029444556],

[72.48506185306744, 34.014972399722865]]]),

{

"LandCover": 0,

"system:index": "2"

})]),

agriculture = /\* color: #b3f022 \*/ee.FeatureCollection(

[ee.Feature(

ee.Geometry.Polygon(

[[[72.57952032584222, 34.019141856032206],

[72.57844744223627, 34.01887507751259],

[72.57913408774408, 34.017932453361496],

[72.57990656394037, 34.018341517957964]]]),

{

"LandCover": 1,

"system:index": "0"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.45327101038144, 34.026218969951294],

[72.45217666910337, 34.026281212961514],

[72.45219812677549, 34.025436482499934],

[72.45356068895505, 34.02551650995686],

[72.4534963159387, 34.02614783502659]]]),

{

"LandCover": 1,

"system:index": "1"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.43598374297196, 34.0275511542622],

[72.43513616492325, 34.02749780391181],

[72.43590864111954, 34.02702654102659],

[72.4359730141359, 34.02745334526087]]]),

{

"LandCover": 1,

"system:index": "2"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.6344471789088, 33.96607453642975],

[72.63305243022106, 33.965878776706326],

[72.63311680323741, 33.9649355644508],

[72.63558443553111, 33.9649355644508],

[72.63491924769542, 33.96621690685471]]]),

{

"LandCover": 1,

"system:index": "3"

})]),

vegetation = /\* color: #ffc82d \*/ee.FeatureCollection(

[ee.Feature(

ee.Geometry.Polygon(

[[[72.46441375104285, 34.00718477881663],

[72.4608732351432, 34.00768283328143],

[72.46095906583167, 34.00652663093645],

[72.46291171399452, 34.00563723380557],

[72.46501456586219, 34.00602856969069]]]),

{

"LandCover": 2,

"system:index": "0"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.44662534085609, 34.00423196735434],

[72.44508038846351, 34.003893988410084],

[72.44533788052894, 34.00273773448252],

[72.44793425885535, 34.00266657988054],

[72.44780551282264, 34.00376946951266]]]),

{

"LandCover": 2,

"system:index": "1"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.60044428662457, 33.99824457643546],

[72.59795519665875, 33.99879605175009],

[72.59780499295391, 33.99696371672983],

[72.59967181042828, 33.99744404138257]]]),

{

"LandCover": 2,

"system:index": "2"

}),

ee.Feature(

ee.Geometry.Polygon(

[[[72.57818248181407, 33.997832877643],

[72.57548954396312, 33.997272501182344],

[72.57568266301219, 33.99685444014548],

[72.57817175297801, 33.99669433111847],

[72.57912661938731, 33.997281396075685],

[72.57855799107615, 33.997646085900165]]]),

{

"LandCover": 2,

"system:index": "3"

})]);

//NDVI Normalized Difference Vegetation Index

var nd = function(image) {

return image.expression('(NIR - RED) / (NIR + RED)', {

'NIR': image.select('B5'),

'RED': image.select('B4')

}).rename('nd')

}

//NDWI: Normalized Differencewater Index

var nw = function(image) {

return image.expression('(GREEN - NIR) / (GREEN - NIR)', {

'NIR': image.select('B5'),

'GREEN': image.select('B3')

}).rename('nw')

}

var image = ee.ImageCollection("LANDSAT/LC08/C01/T1\_TOA")

.filterBounds(roi)

.filterDate('2020-02-01', '2020-08-30')

.filterMetadata('CLOUD\_COVER', 'less\_than', 50)

.map(function (image) {

return image // Add indexes to each image in the collection

.addBands(nd(image))

.addBands(nw(image))

})

.median()

// //landsat05

var ndvi = function(image) {

return image.expression('(NIR - RED) / (NIR + RED)', {

'NIR': image.select('B5'),

'RED': image.select('B4')

}).rename('ndvi')

}

//EVI: Enhanced Vegetation Index

var ndwi = function(image) {

return image.expression('(GREEN - NIR) / (GREEN - NIR)', {

'NIR': image.select('B5'),

'GREEN': image.select('B3')

}).rename('ndwi')

}

var image2 = ee.ImageCollection("LANDSAT/LT05/C02/T1\_TOA")

.filterBounds(roi)

.filterDate('1990-02-01', '2010-08-30')

//.filterMetadata('CLOUD\_COVER', 'less\_than', 50)

.map(function (image) {

return image // Add indexes to each image in the collection

.addBands(ndvi(image))

.addBands(ndwi(image))

})

.median()

//var stack = ee.ImageCollection(image.merge(image2));

var combineimages=image

.addBands(image).addBands(image2);

print(combineimages,"combine image")

// var bandNames = combineimages.bandNames();

// //Training a regression model for AGB

// var bands = [ 'B2', 'B3', 'B4','B5','B6','B7'

// ,'nd',

// 'nw'

// ];

var referenceData = water.merge(agriculture).merge(vegetation);

var bands = (['nd', 'nw','ndvi','ndwi','B2', 'B3', 'B4', 'B5', 'B6', 'B7'])

var trainingData = combineimages.select(bands).sampleRegions({

collection: referenceData,

properties: ['LandCover'],

scale: 30

})

var classifier = ee.Classifier.smileRandomForest(500)

.train({

features: trainingData,

classProperty: 'LandCover',

inputProperties: bands

})

var classified = combineimages.select(bands).classify(classifier)

Map.centerObject(roi, 11)

Map.addLayer(classified, {

min: 0,

max: 5,

palette: ['1557da' ,'157B16','8ADA15']

},

'classification')

**S5. Confusion matrices**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **1990** | | | | | | | |
| **Class Type** | **Agriculture** | **Water** | **Baresoil** | **Vegetation** | **Total** | **User Accuracy** |
| **Agriculture** | 406 | 4 | 4 | 11 | 425 | 0.955294118 |
| **Water** | 2 | 189 | 6 | 8 | 205 | 0.92195122 |
| **Baresoil** | 6 | 4 | 158 | 7 | 175 | 0.902857143 |
| **Vegetation** | 3 | 2 | 2 | 188 | 195 | 0.964102564 |
| **Total** | 417 | 199 | 170 | 214 | 1000 |  |
|  |  |  |  |  |  |  |
| **Producer Accuracy** | 0.9736211 | 0.949749 | 0.929411765 | 0.87850467 |  |  |
|  |  |  |  |  | Total | Overall Accuracy |
|  |  |  |  |  | 941 | 0.941 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **2002** | | | | | | |
| **Class Type** | **Agriculture** | **Water** | **Baresoil** | **Vegetation** | **Total** | **User Accuracy** |
| **Agriculture** | 404 | 6 | 5 | 10 | 425 | 0.950588235 |
| **Water** | 2 | 190 | 4 | 9 | 205 | 0.926829268 |
| **Baresoil** | 6 | 5 | 155 | 9 | 175 | 0.885714286 |
| **Vegetation** | 6 | 4 | 5 | 180 | 195 | 0.923076923 |
| **Total** | 418 | 205 | 169 | 208 | 1000 |  |
|  |  |  |  |  |  |  |
| **Producer Accuracy** | 0.9665072 | 0.926829 | 0.917159763 | 0.86538462 |  |  |
|  |  |  |  |  | Total | Overall Accuracy |
|  |  |  |  |  | 929 | 0.929 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **2010** | | | | | | | |
| **Class Type** | **Agriculture** | **Water** | **Baresoil** | **Vegetation** | **Total** | **User Accuracy** |
| **Agriculture** | 405 | 5 | 6 | 9 | 425 | 0.952941176 |
| **Water** | 2 | 192 | 3 | 8 | 205 | 0.936585366 |
| **Baresoil** | 5 | 4 | 157 | 9 | 175 | 0.897142857 |
| **Vegetation** | 5 | 3 | 4 | 183 | 195 | 0.938461538 |
| **Total** | 417 | 204 | 170 | 209 | 1000 |  |
|  |  |  |  |  |  |  |
| **Producer Accuracy** | 0.971223 | 0.941176 | 0.923529412 | 0.87559809 |  |  |
|  |  |  |  |  | Total | Overall Accuracy |
|  |  |  |  |  | 937 | 0.937 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **2020** | | | | | | |
| **Class Type** | **Agriculture** | Water | **Baresoil** | **Vegetation** | **Total** | **User Accuracy** |
| **Agriculture** | 408 | 3 | 3 | 11 | 425 | 0.96 |
| **Water** | 1 | 191 | 4 | 9 | 205 | 0.931707317 |
| **Baresoil** | 4 | 3 | 160 | 8 | 175 | 0.914285714 |
| **Vegetation** | 4 | 2 | 3 | 186 | 195 | 0.953846154 |
| **Total** | 417 | 199 | 170 | 214 | 1000 |  |
|  |  |  |  |  |  |  |
| **Producer Accuracy** | 0.9784173 | 0.959799 | 0.941176471 | 0.86915888 |  |  |
|  |  |  |  |  | Total | Overall Accuracy |
|  |  |  |  |  | 945 | 0.945 |

**S6. LULC changes from 1990-2020**



**S7. Questionnaire Proforma**

**LULC analysis of Ghazi Barotha Hydropower Project, KP, Pakistan**

**Questionnaire Proforma for Households**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Questionnaire Code\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_       Date of Interview\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Interviewer\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_       Designation of Interviewer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Respondent\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**District\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_      Union Council\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**A)** **DEMOGRAPHIC INFORMATION**

|  |  |
| --- | --- |
| Male | Female |

1.  Gender of Respondent

2.      Age of Respondent \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (years)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Uneducated | Primary | Secondary | Intermediate | University |

3.      Education level

|  |  |  |
| --- | --- | --- |
| Single | Married | Divorced |

4.      Marital Status

|  |  |
| --- | --- |
| Nuclear | Joint |

5.      Family Structure

 6.      Family members Total:\_\_\_\_\_\_\_\_ Males: \_\_\_\_\_\_\_ Females: \_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Household head | Spouse | Son/Daughter |

7.      Position in Household

Other (specify) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8.      Respondents occupation (Before GBHP)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Farming | Livestock | Fishing | Formal employment | Business |

Other (specify) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9.      Respondents occupation (After GBHP)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Farming | Livestock | Fishing | Formal employment | Business |

Other (specify) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10.  Respondents’ current monthly income \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Rs)

11.  Land Holding (Kanals)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Agricultural | Residential | Commercial | Forest | Other (specify) | Total |
|  |  |  |  |  |  |

|  |  |  |
| --- | --- | --- |
| Inherited | Purchased | Leased/ Rented |

12.  Means of Land Acquisition

Other (specify) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Landowner | Owner cum tenant | Tenant |

 13.  Tenurial status (in case of agricultural land)

Other (specify) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**B)** **PRE AND POST LULC CHANGE AND RESONS**

1. **AGRICULTURE**

|  |  |  |
| --- | --- | --- |
| **Period** | **Selected Response** | **Reasons/ Remarks** |
| Pre GBHP (1990-2002) | Increased |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2003-2010) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2010-2020) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |

General comments:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. VEGETATION**

|  |  |  |
| --- | --- | --- |
| **Period** | **Selected Response** | **Reasons/ Remarks** |
| Pre GBHP (1990-2002) | Increased |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2003-2010) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2010-2020) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |

General comments:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. BARESOIL**

|  |  |  |
| --- | --- | --- |
| **Period** | **Selected Response** | **Reasons/ Remarks** |
| Pre GBHP (1990-2002) | Increased |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2003-2010) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2010-2020) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |

General comments:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4. WATER**

|  |  |  |
| --- | --- | --- |
| **Period** | **Selected Response** | **Reasons/ Remarks** |
| Pre GBHP (1990-2002) | Increased |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2003-2010) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |
| Post GBHP (2010-2020) | Increased |  |  |
|  |
| Decreased |  |
|  |
| No change |  |
|  |

General comments:

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