# Appendix A

## Water footprint checklists

The beginning of processing to assess water footprint could be started through a checklists illustrated by Hoekstra *et al.* (2009) as follows;

**1) General**

1.1) What is the ultimate target? Awareness-raising, hotspot identification, policy formulation or quantitative target setting?

- To expose the amount of water that farmers used for sugarcane cultivation beneath 3 components of water footprint concepts. Then, present and discuss this study to farmers.

1.2) Is there a focus on one particular phase? Focus on accounting, sustainability assessment or response formulation?

- There is a focus for water footprint accounting (Blue, green, and grey water footprint ($m^3$/ton)) at first and the result will be reported to the farmer and company staff, and stakeholder in this area for sustainability assessment or response formulation later.

1.3) What is the scope of interest? Direct and/or indirect water footprint? Green, blue and/or grey water footprint?

- The scope of interest is sugarcane cultivation with direct water footprint only (*Direct water footprint* means excluding calculation for packaging or transportation).
- Green, blue and grey water footprint will be assessed as much as possible.

1.4) How to deal with time? Aiming at assessment for one particular year or at the average over a few years, or trend analysis?

- Growing season of sugarcane cultivation in 2011-2012, a 12-month period, will be taken in this assessment.

**2) Process water footprint assessment**

2.1) What process will be considered? One specific process or alternative, substitutable processes? (in order to compare the water footprints of alternative techniques)

- One specific process will be disclosed the sugarcane cultivation of water footprint for this area as follows; using CROPWAT 8.0 model for green and blue water footprint and using equation to follow the water footprint assessment manually for grey water footprint.

2.2) What scale? One specific process in a specific location or the same process in different locations?

- Mae Sot District will be a hotspot in environmental issue in Tak Province (contaminated area with Cadmium). However, around 23,966 rai in Mae Sot District was planted sugarcane that supported by Mae Sot Clean Energy Company (MSCEC).

**3) Product water footprint assessment**

3.1) What product to consider? One stock-keeping unit of a particular brand, one particular sort of product or a whole product category?

- Only sugarcane that was transported into Mae Sot Clean Energy Company (MSCEC) will be considered
- Growing season (during 2011-2012)
- Calculate for crop production in fields only before transport into the factory from cultivation to harvesting.

3.2) What scale? Include product(s) from one field or factory, one or more companies or one or more production regions?

- One product (sugarcane) and all fields of sugarcane cultivation in Mae Sot (23,966 rai) for transport into one MSCEC.

**4) Consumer or community water footprint assessment**

Which community? One individual consumer or the consumers within a municipality, province or state?

- 23,966 rai of sugarcane fields in Mae Sot District, Tak Province.

**5) Assessment of the water footprint within a geographically delineated area**

5.1) What are the area boundaries? A catchment, river basin, municipality, province, state or nation?

- The scope of this study is assessed sugarcane field in Mae Sot District (23,966 rai), Tak Province, Thailand.

5.2) What is the field of interest? Examine how the water footprint within the area is reduced by importing virtual water and how the water footprint within the area is increased by making products for export, analyse how the area's water resources are allocated over various purposes, and/or examine where the water footprint within the area violates local environmental flow requirements and ambient water quality standards?

- In June 2004, the US Food and Drug Administration reported that the rice cadmium contamination was expressed in Mae Sot District, Tak Province (Simmons *et al*., 2005). Thai government has prohibited rice cultivation and introduced other crops which excluded in the food chain. In 2006, the Mae Sot Clean Energy Company (MSCEC) as the ethanol producer factory was established in this contaminated area. The factory tried to support sugarcane cultivation to farmer and bought it back for ethanol production. Sugarcane cultivation requires a lot of water (Scholten, 2009). Nowadays, in this area has no report of water usage sustainable. In recent time, Thailand had a severe drought that lead to decline of yield in agricultural sector. As above-mentioned, although, Thai government promoted the sugarcane cultivation in this area, the water usage for sugarcane cultivation is a large amount. This concern is essential for suitable and sustainable usage. At the present, the water usage situation can show by water footprint.

# Appendix B

## Precipitation in Mae Sot (Oct. 2011- Sep 2012)

**Table B-1** Climate data's output since Oct. 2011 to Sep. 2012 by CROPWAT 8.0.

| Day | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 5.3 | 7.1 | 31.1 | 0.6 | 0.7 | 0 | 0 |
| 2 | 0 | 0.2 | 0 | 0 | 0 | 0 | 54.1 | 6.1 | 1.2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 1.8 | 4.6 | 29 | 0.7 | 48.1 | 0 | 0 |
| 4 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 20.3 | 1.3 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 50.7 | 2.8 | 0 | 9.2 | 40.9 | 15.3 | 0 | 0 |
| 6 | 0 | 0 | 0 | 8.7 | 95.8 | 0 | 7.1 | 11.1 | 23.2 | 3 | 0 | 0 |
| 7 | 0 | 0 | 0 | 1.3 | 7.8 | 78.9 | 4 | 18.1 | 28.1 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 21.1 | 0.6 | 47.5 | 1.1 | 0.8 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 71.4 | 2.7 | 5.2 | 0 | 0 |
| 10 | 0 | 0 | 7.5 | 0 | 0 | 2.3 | 0 | 30.3 | 3.6 | 5.8 | 0 | 0 |
| 11 | 0 | 0 | 0.5 | 0 | 0 | 1.9 | 0 | 23.1 | 0 | 1.7 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 5.8 | 1.3 | 0 | 34.1 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0.4 | 3 | 0 | 14.9 | 0 | 0 | 0 | 0 |
| 14 | 0.6 | 0 | 0 | 0 | 0 | 19.6 | 0.6 | 15.6 | 17.8 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 4.9 | 0.6 | 7.4 | 0 | 28.8 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 11.1 | 4.2 | 15.1 | 10.5 | 0.2 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 8.1 | 7.1 | 14.5 | 7.8 | 0.8 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 1.7 | 10.6 | 71.6 | 72.6 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 | 1.2 | 20.3 | 6.9 | 15.1 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 | 23.6 | 0.5 | 15.9 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 | 12.6 | 7.4 | 7.8 | 0 | 2.2 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 2.2 | 19.1 | 0.7 | 0 | 0 | 0 | 0 |
| 23 | 0 | 0 | 0 | 0 | 7.5 | 7 | 59.1 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | 0 | 0 | 0 | 0 | 6.8 | 66.1 | 9.4 | 0 | 0 | 0 | 0 |

**Table A-1** Climate data's output since Oct. 2011 to Sep. 2012 by CROPWAT 8.0. (Cont.)

| Day | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 0 | 0 | 0 | 0 | 0 | 42.4 | 11.9 | 3.1 | 0 | 0 | 0 | 0 |
| 26 | 0 | 0 | 0 | 0 | 1 | 94.2 | 29.7 | 0 | 0 | 0 | 0 | 0 |
| 27 | 0 | 0 | 0 | 0 | 0.7 | 17.5 | 17.4 | 0.2 | 4.3 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 3.2 | 1.2 | 0 | 21.8 | 0 | 0.2 | 0 | 0 | 0 |
| 29 | 0 | - | 0 | 1.9 | 24.8 | 1.9 | 21.8 | 2.1 | 0 | 0 | 0 | 0 |
| 30 | 0 | - | 0 | 0 | 2.4 | 7 | 22.2 | 8.8 | 26.2 | 0 | 0 | 0 |
| 31 | 0 | - | 3.2 | - | 2.7 | - | 27.9 | 7.6 | - | 0 | - | 0 |
| A | 0.6 | 0.2 | 11.2 | 20.1 | 211.8 | 409.2 | 480.8 | 535.4 | 163.2 | 111.8 | 0 | 0 |
| B | 0.6 | 0.2 | 10.9 | 18.9 | 105.4 | 165.9 | 172.3 | 165 | 103.2 | 77.4 | 0 | 0 |
| Summation of total rainfall every month (mm) | | | | | | | | | | 1944.3 | | |
| Summation of total effective rainfall every month (mm) | | | | | | | | | | 819.8 | | |

A = total rainfall, B = total effective rainfall

# Appendix C

## Correlation between heavy metals and trace elements

**Table C-1** Correlations of heavy metals and trace elements in 1st year sugarcane root, in polluted site, in August 2011 (wet season)

| | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|
| Ba | 1.000 | | | | | | | | |
| Ca | 0.765* | 1.000 | | | | | | | |
| Cd | 0.185 | 0.367 | 1.000 | | | | | | |
| Cr | 0.336 | 0.067 | 0.000 | 1.000 | | | | | |
| Cu | -0.008 | -0.300 | -0.083 | 0.767* | 1.000 | | | | |
| Fe | 0.941** | 0.883** | 0.400 | 0.333 | -0.083 | 1.000 | | | |
| Mg | 0.950** | 0.783* | 0.183 | 0.250 | -0.167 | 0.917** | 1.000 | | |
| Mn | 0.975** | 0.783* | 0.100 | 0.250 | -0.100 | 0.900** | 0.967** | 1.000 | |
| Zn | 0.513 | 0.717* | 0.417 | -0.500 | -0.533 | 0.583 | 0.500 | 0.533 | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-2** Correlations of heavy metals and trace elements in 3rd year sugarcane root, in polluted site, in August 2011 (wet season)

| | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|
| Ba | 1.000 | | | | | | | | |
| Ca | 0.833** | 1.000 | | | | | | | |
| Cd | 0.467 | 0.583 | 1.000 | | | | | | |
| Cr | 0.417 | 0.250 | -0.433 | 1.000 | | | | | |
| Cu | 0.467 | 0.300 | -0.433 | 0.833** | 1.000 | | | | |
| Fe | 0.667* | 0.467 | -0.200 | 0.867** | 0.900** | 1.000 | | | |
| Mg | 0.750* | 0.833** | 0.350 | 0.467 | 0.583 | 0.700* | 1.000 | | |
| Mn | 0.867** | 0.650 | 0.117 | 0.533 | 0.700* | 0.850** | 0.683* | 1.000 | |
| Zn | 0.650 | 0.750* | 0.900** | -0.150 | -0.083 | 0.117 | 0.583 | 0.367 | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-3** Correlations of heavy metals and trace elements in 1st year sugarcane root, in polluted site, in February 2012 (dry season)

| | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|
| Ba | 1.000 | | | | | | | | |
| Ca | 0.933** | 1.000 | | | | | | | |
| Cd | 0.883** | 0.967** | 1.000 | | | | | | |
| Cr | 0.733* | 0.600 | 0.517 | 1.000 | | | | | |
| Cu | 0.950** | 0.933** | 0.933** | 0.683* | 1.000 | | | | |
| Fe | 0.967** | 0.883** | 0.850** | 0.733* | 0.917** | 1.000 | | | |
| Mg | 0.517 | 0.617 | 0.517 | 0.450 | 0.583 | 0.367 | 1.000 | | |
| Mn | 0.583 | 0.483 | 0.400 | 0.883** | 0.500 | 0.600 | 0.417 | 1.000 | |
| Zn | 0.917** | 0.933** | 0.933** | 0.683* | 0.967** | 0.917** | 0.483 | 0.467 | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-4** Correlations of heavy metals and trace elements in 3rd year sugarcane root, in polluted site, in February 2012 (dry season)

| | Ba | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|
| Ba | 1.000 | | | | | | | | |
| Ca | -0.017 | 1.000 | | | | | | | |
| Cd | 0.867** | -0.133 | 1.000 | | | | | | |
| Cr | 0.883** | -0.233 | 0.883** | 1.000 | | | | | |
| Cu | 0.833** | -0.183 | 0.967** | 0.850** | 1.000 | | | | |
| Fe | 0.750* | 0.467 | 0.633 | 0.567 | 0.550 | 1.000 | | | |
| Mg | 0.783* | -0.233 | 0.817** | 0.867** | 0.817** | 0.367 | 1.000 | | |
| Mn | 0.033 | -0.883** | -0.033 | 0.083 | 0.067 | -0.483 | 0.183 | 1.000 | |
| Zn | .0933** | -0.283 | 0.900** | 0.967** | 0.867** | 0.617 | 0.800** | 0.167 | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-5** Correlations of heavy metals and trace elements in soil's polluted site, in August 2011 (wet season)

| | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|
| Ca | 1.000 | | | | | | | |
| Cd | -0.477 | 1.000 | | | | | | |
| Cr | -0.183 | 0.5 | 1.000 | | | | | |
| Cu | 0.583 | -0.65 | -0.667* | 1.000 | | | | |
| Fe | 0.350 | -0.767* | -0.667* | 0.617 | 1.000 | | | |
| Mg | -0.083 | 0.633 | 0.583 | -0.433 | -0.700* | 1.000 | | |
| Mn | -0.450 | -0.133 | -0.617 | -0.067 | 0.5 | -0.533 | 1.000 | |
| Zn | -0.483 | 0.717* | 0.367 | -0.833** | -0.583 | 0.600 | 0.133 | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-6** Correlations of heavy metals and trace elements in soil's un-polluted site, in August 2012 (wet season)

| | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|
| Ca | 1.000 | | | | | | | |
| Cd | 0.717* | 1.000 | | | | | | |
| Cr | 0.333 | 0.300 | 1.000 | | | | | |
| Cu | 0.833** | 0.683* | 0.583 | 1.000 | | | | |
| Fe | 0.883** | 0.850** | 0.333 | 0.717* | 1.000 | | | |
| Mg | 0.367 | 0.500 | 0.533 | 0.683* | 0.500 | 1.000 | | |
| Mn | 0.817** | 0.850** | 0.217 | 0.600 | 0.950** | 0.367 | 1.000 | |
| Zn | 0.800** | 0.667* | 0.433 | 0.850** | 0.850** | 0.800** | 0.717* | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-7** Correlations of heavy metals and trace elements in soil's polluted site, in February 2012 (dry season)

| | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|
| Ca | 1.000 | | | | | | | |
| Cd | -0.476 | 1.000 | | | | | | |
| Cr | 0.357 | -0.071 | 1.000 | | | | | |
| Cu | -0.429 | -0.190 | 0.262 | 1.000 | | | | |
| Fe | -0.452 | -0.024 | 0.357 | 0.976** | 1.000 | | | |
| Mg | -0.119 | 0.810* | 0.024 | -0.214 | -0.048 | 1.000 | | |
| Mn | -0.786* | 0.595 | 0.000 | 0.643 | 0.738* | 0.476 | 1.000 | |
| Zn | 0.262 | 0.643 | 0.238 | -0.405 | -0.238 | 0.905** | 0.143 | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

**Table C-8** Correlations of heavy metals and trace elements in soil's un-polluted site, in February 2012 (dry season)

| | Ca | Cd | Cr | Cu | Fe | Mg | Mn | Zn |
|---|---|---|---|---|---|---|---|---|
| Ca | 1.000 | | | | | | | |
| Cd | 0.159 | 1.000 | | | | | | |
| Cr | -0.317 | 0.017 | 1.000 | | | | | |
| Cu | 0.267 | 0.460 | 0.650 | 1.000 | | | | |
| Fe | 0.267 | 0.544 | 0.677* | 0.950** | 1.000 | | | |
| Mg | -0.133 | 0.778* | 0.283 | 0.467 | 0.517 | 1.000 | | |
| Mn | -0.250 | 0.820** | 0.367 | 0.500 | 0.567 | 0.817** | 1.000 | |
| Zn | 0.317 | 0.753* | 0.200 | 0.533 | 0.567 | 0.850** | 0.667* | 1.000 |

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

# Appendix D

## Concentration of heavy metal and trace element

**Table D-1** Concentration of heavy metal and trace element in soil in August 2011 and February 2012

| Elements | Month | Concentration in August (mg/kg) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Contaminated site | | | | Control site | | | |
| | | $\bar{X}$ | min | max | SD | $\bar{X}$ | min | max | SD |
| Ca | Aug. | 5,990 | 5,250 | 6,810 | 781 | 8,100 | 7,360 | 8,470 | 632 |
| | Feb. | 4,960 | 3,220 | 6,290 | 1,570 | 5,670 | 5,120 | 6,320 | 603 |
| Cd | Aug. | 9.3 | 5.5 | 15.3 | 5.3 | 2.5 | 2.3 | 2.6 | 0.2 |
| | Feb. | 11.3 | 7.7 | 15.9 | 4.2 | 2.8 | 2.5 | 3.1 | 0.3 |
| Cr | Aug. | 14.3 | 12.9 | 15.4 | 1.3 | 38.2 | 37.7 | 38.8 | 0.6 |
| | Feb. | 12.4 | 11.9 | 13.2 | 0.6 | 34.2 | 32.7 | 35.6 | 1.5 |
| Cu | Aug. | 9.4 | 8.4 | 9.9 | 0.8 | 21.2 | 20.3 | 22.2 | 1.0 |
| | Feb. | 7.1 | 6.1 | 8.0 | 0.9 | 17.3 | 16.7 | 17.7 | 0.5 |
| Fe | Aug. | 15,700 | 15,000 | 16,600 | 839 | 32,700 | 31,800 | 33,100 | 726 |
| | Feb. | 17,100 | 16,000 | 18,400 | 1,220 | 33,400 | 32,200 | 34,200 | 1,100 |
| Mg | Aug. | 1,390 | 1,250 | 1,480 | 123 | 3,080 | 3,010 | 3,130 | 61 |
| | Feb. | 1,560 | 1,460 | 1,690 | 121 | 2,680 | 2,500 | 2,890 | 201 |
| Mn | Aug. | 485 | 436 | 509 | 42.1 | 1,450 | 1,250 | 1,580 | 176 |
| | Feb. | 545 | 365 | 802 | 228 | 1,490 | 1,190 | 1,780 | 294 |
| Zn | Aug. | 347 | 323 | 389 | 36 | 73 | 70 | 75 | 3 |
| | Feb. | 285 | 267 | 320 | 30 | 59 | 55 | 65 | 6 |

**Table D-2** Concentrations of heavy metals and trace elements in sugarcane root in August 2011 and February 2012

| Elements | Month | Concentration (mg/kg) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st yr. of root in contaminated site | | | | 3rd yr. of root in contaminated site | | | | 1st yr. of root in control site | | | | 3rd yr. of root in control site | | | |
| | | $\bar{X}$ | min | max | SD | $\bar{X}$ | min | max | SD | $\bar{X}$ | min | max | SD | $\bar{X}$ | min | max | SD |
| Ba | Aug. | 16.5 | 13.8 | 20.0 | 3.2 | 29.4 | 23.5 | 37.7 | 7.4 | 53.8 | 48.0 | 63.3 | 8.34 | 21.7 | 20.3 | 24.2 | 2.18 |
| | Feb. | 22.0 | 17.0 | 28.3 | 5.8 | 25.0 | 18.7 | 36.2 | 2.8 | 22.3 | 20.1 | 24.3 | 2.1 | 20.8 | 18.5 | 23.2 | 2.3 |
| Ca | Aug. | 2,960 | 2,340 | 3,290 | 539 | 2,190 | 1,480 | 3,460 | 1,090 | 2,250 | 1,790 | 2,580 | 409 | 2,280 | 1,870 | 2,830 | 495 |
| | Feb. | 5,430 | 4,420 | 6,190 | 909 | 5,210 | 2,690 | 6,730 | 2,190 | 2,260 | 1,750 | 2,850 | 550 | 2,120 | 1,690 | 2,430 | 385 |
| Cd | Aug. | 6.7[a] | 5.8 | 7.5 | 0.9 | 6.2[a] | 2.4 | 13 | 5.8 | ND | ND | ND | ND | ND | ND | ND | ND |
| | Feb. | 4.2[a] | 2.0 | 7.6 | 3.0 | 2.0[a] | 1.1 | 3.3 | 1.1 | ND | ND | ND | ND | ND | ND | ND | ND |
| Cr | Aug. | 2.0 | 1.2 | 2.5 | 0.7 | 2.3 | 1.4 | 3.4 | 1.0 | 6.8 | 5.5 | 7.7 | 1.2 | 2.2 | 1.3 | 3.8 | 1.4 |
| | Feb. | 2.4 | 0.9 | 4.9 | 2.2 | 2.5 | 0.6 | 4.7 | 2.1 | 2.6 | 1.4 | 3.2 | 1.0 | 2.2 | 1.6 | 3.3 | 0.9 |
| Cu | Aug. | 4.2 | 3.7 | 4.8 | 0.8 | 8.6 | 2.4 | 12.4 | 5.4 | 4.9 | 3.3 | 6.7 | 1.7 | 11.8 | 9.0 | 16.8 | 4.3 |
| | Feb. | 4.6 | 1.8 | 8.1 | 3.2 | 6.2 | 4.8 | 7.9 | 1.6 | 2.8 | 1.7 | 4.3 | 1.3 | 3.4 | 2.3 | 4.8 | 1.3 |
| Fe | Aug. | 3,040 | 1,950 | 3,920 | 1,002 | 4,210 | 2,970 | 5,170 | 1,130 | 7,420 | 5,550 | 8,540 | 1,630 | 3,390 | 2,590 | 3,840 | 690 |
| | Feb. | 3,370 | 2,205 | 4,680 | 1,250 | 4,160 | 2,900 | 5,800 | 1,485 | 2,790 | 2,500 | 3,300 | 450 | 3,460 | 3,190 | 3,620 | 233 |
| Mg | Aug. | 1,070 | 841 | 1,270 | 213.9 | 997 | 781 | 1,130 | 188 | 1,390 | 1,140 | 1,730 | 304 | 897 | 859 | 929 | 34 |
| | Feb. | 1,370 | 1,280 | 1,420 | 73.5 | 859 | 725 | 968 | 123 | 1,010 | 949 | 1,060 | 57.3 | 1,350 | 1,030 | 1,810 | 399 |
| Mn | Aug. | 129 | 94 | 163 | 34 | 209 | 113 | 260 | 83.6 | 259 | 224 | 291 | 33 | 168 | 125 | 229 | 54 |
| | Feb. | 121 | 91 | 157 | 33 | 135 | 109 | 185 | 43 | 91.9 | 78 | 106 | 14 | 100 | 88 | 111 | 11 |
| Zn | Aug. | 94 | 72 | 113 | 20 | 171 | 109 | 275 | 91 | 33 | 25 | 40 | 7 | 40 | 30 | 46 | 9 |
| | Feb. | 82 | 45 | 126 | 41 | 113 | 77 | 155 | 39 | 19 | 7 | 39 | 17 | 15 | 7 | 24 | 8 |

# CURRICULUM VITAE

| | |
|---|---|
| Author's Name | Mr. Nattawut Sareein |
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| Education | 2010 B.S. (Biology), Chiang Mai University, Chaing Mai, Thailand |
| Scholarship | Development and promotion of science and technology talent project (DPST) |
| Oral presentations | Sareein, N., Phalaraksh, C., Kawashima, M. and Chantara, S. Cadmium Accumulation in Sugarcane, Rice and Pickerel Weed at Mae Sot District, Tak Province, Thailand. Environmental Cadmium Conference 2013 (International conference), Chiang Mai, Thailand 14-15 February 2013. |
| Graduated Seminars | Sareein, N., 2012. The water footprint of sugarcane production process. Graduated Seminar 1, 10$^{th}$ February 2012, ScB 1720, Science Complex I Faculty of Science, Chiang Mai University. |



Sareein, N., 2012. Water Footprint of Sugarcane Cultivation in Mae Sot District, Tak Province. Graduated Seminar 1, 28$^{th}$ July 2013, ScB 1720, Science Complex I Faculty of Science, Chiang Mai University. (Best Oral Presentation)

Poster presentation Sareein, N., Phalaraksh, C. and Kawashima, M. 2013. Water Footprint of Sugarcane Cultivation in Mae Sot District, Tak Province, Thailand. International Conference on Life Science & Biological Engineering, Osaka, Japan, 7-9 November, 2013